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A Climate Action Plan for Bucknell University

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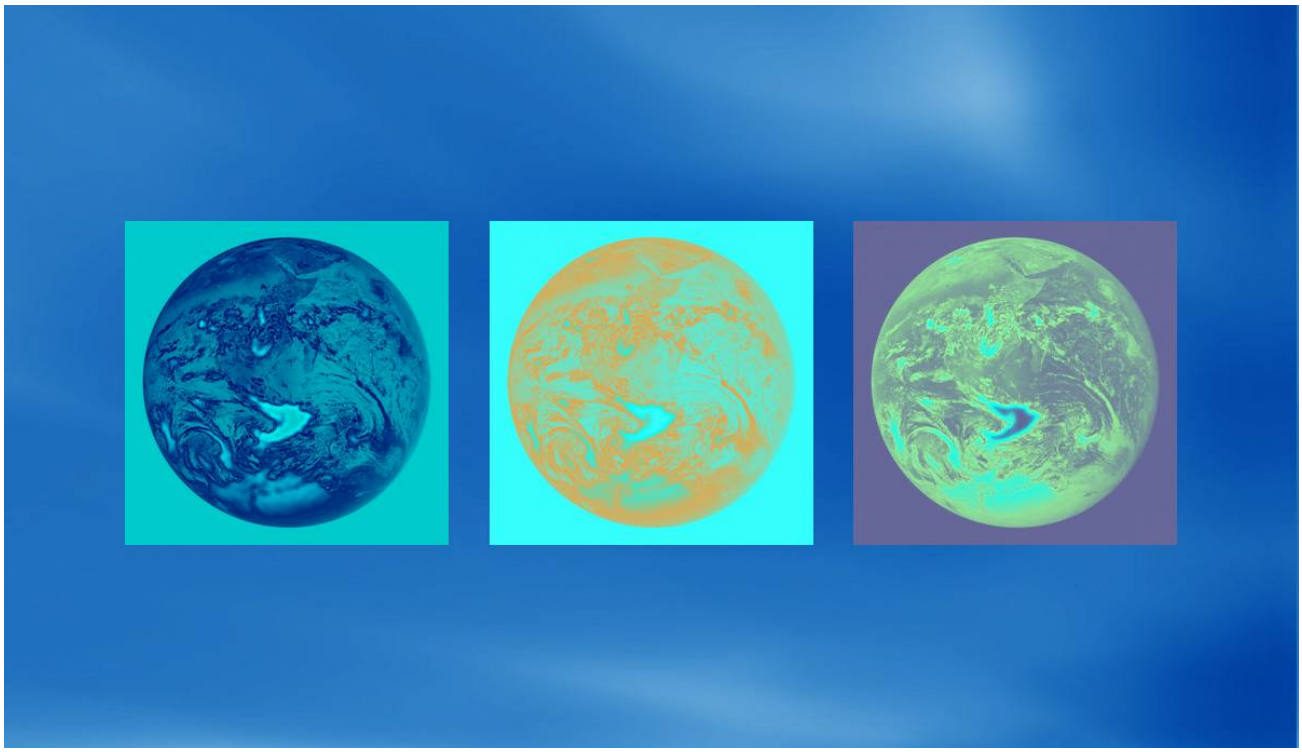

A Climate Action Plan for Bucknell University

As specified under the American College and University Presidents Climate Commitment

First complete draft:
March 1st 2010

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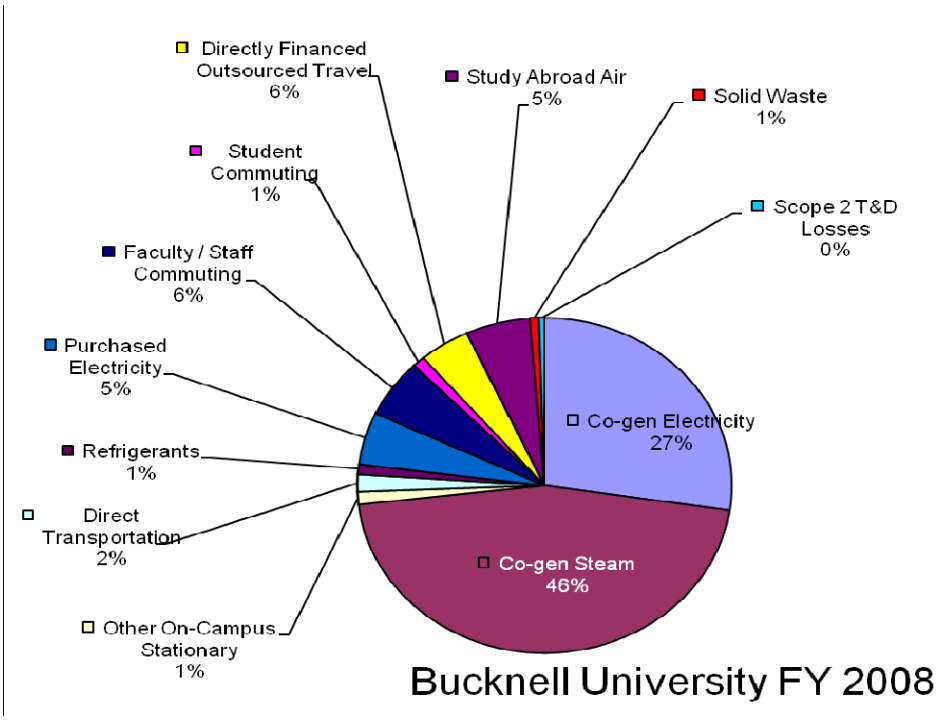
Executive Summary

- In 2008, the year for which reporting is most complete, Bucknell University released an estimated 42,000 Metric tons of CO_2 equivalents of greenhouse gas emissions (GHG)

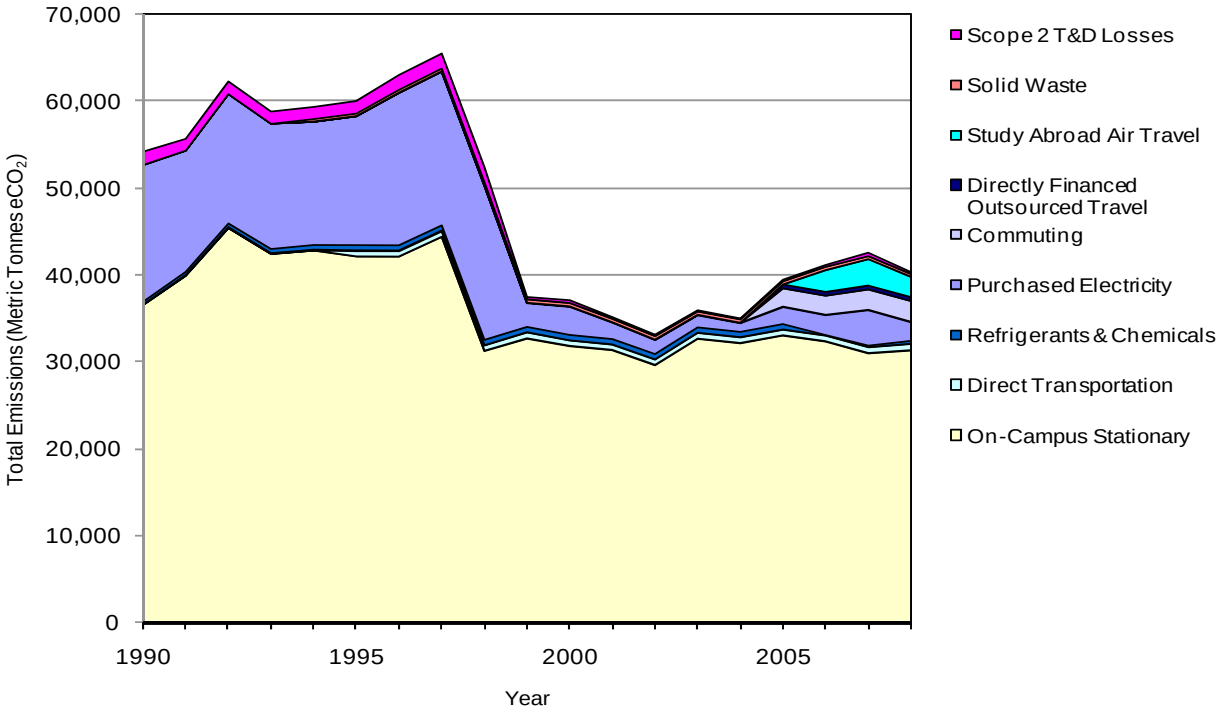
- Breaking this down by source reveals that the three major sources of the University's GHG emissions are heat, electricity, and air travel (see diagram below)



Bucknell's GHG emissions at a glance, by year and scope (sources: GHG04 and GHG08)

- Broadly speaking, the major sources of Bucknell's GHG gross emissions include: steam and electricity generation (co-generation plant), other on-campus stationary sources, university vehicle fleet, and losses from refrigerants and chemicals (which fall under Scope 1); purchased electricity (Scope 2); and air travel and commuting (Scope 3). For an overview of historic GHG emissions, see the graph below:

- FYs 2006 – 2008 include new student and faculty/staff commuting data (process also described in Robertson 2008). These newly catalogued sources give the appearance of significant increases in Scope 3 emissions as a proportion of the total inventory. **<u>However, rather than interpreting these as a change in activities, these data should be viewed as an improvement in reporting</u>.**



- Five main factors have influenced Bucknell's documented emissions: (1) transition to a natural gas-fueled cogeneration plant by FY 1999 (this is the single most important factor); (2) availability of new transportation emissions data; (3) steady campus growth; (4) changes in the purchase of renewable power; and (5) ongoing implementation of energy upgrades by facilities staff.

- Importantly, the transition to cleaner-burner natural gas and the greater efficiency of the CHP dramatically reduced the gross (pre-offsets) GHG emissions from approximately **65,600** (in 1990) to **38,800** MTCE (in 2000), roughly a 41% decrease in gross emissions.

- The full-time student body at Bucknell has hovered consistently close to 3500 students over the period 1990 - 2008. Energy use per student over this time period dipped with the conversion from coal to CHP and remained fairly constant afterward, excepting a slight upward trend reflecting increased data coverage (e.g., transportation emissions).

- In the early 2000's Bucknell experienced significant campus expansion (upwards of 300,000 GSF). Additions included a 300-bed student dormitory (McDonnell Hall, 2000), three academic buildings (Weis Music 2000, Breakiron 2004, and the O'Leary Center 2002, and several recreational facilities (Langone Athletics and Recreation Center, Sojka Pavilion, and Kinney Natatorium, 2002 – 2003). Despite these growth trends, energy usage (in MMBtu) per 1000 GSF of built space has held relatively steady from FY 1998 to 2008.

- Since 2005, Bucknell has obtained RECs (renewable energy credits) for its purchased wind power. The amount of renewable energy purchased has grown significantly: Bucknell purchased 1 million kWh of wind power annually from 2003 to 2008 (reducing total emissions by approximately 650 MTCE per year, and 2.5 million kWh (equivalent to

19,000 MMBtu in terms of energy supply) in FY 2008. These changes, it should be noted, are not reflected in Bucknell's gross emissions, but in its **net emissions**, counted after taking offsets into account. (Bucknell increased wind power purchases in 2009 to 4 million kWh.)

- Demographics/built space: No large changes are expected in terms of student enrollment. However, by 2013 new buildings will increase the total area of built space on campus and necessitate increased energy consumption and GHG emissions. Expectations are for a new academic complex of 65,000 gross square feet (GSF) plus 130,000 GSF of new residential housing.
- Under the business-as-usual scenario, increased data coverage of transportation (especially DFOT), augmented built space, and inclusion of some previously hidden emissions from off-campus residences, are likely to increase overall campus emissions in the range of **5-10% above** FY 2008 levels by 2015.

* * *

- Four logical strategies for reducing GHG emissions in the short term would be:

  1. reducing demand for fossil fuel-based heating/cooling (representing steam production),
  2. reducing demand for electricity,
  3. minimizing emissions from purchased electricity , and
  4. reducing emissions from air travel.

- The first two strategies could be addressed most effectively in the short run through two broad-based tactics: The first would be to hire, within the Bucknell Facilities, an "Energy Manager" whose overall objective would be to identify and implement specific energy conservation initiatives within the university's operations.

- The second broad-based tactic for short term energy conservation would involve the implementation of a residential sustainability education program in Bucknell's residence halls. Because the bulk of Bucknell's population is students, and because the vast majority of these students live on campus 24-hours, 7 days per week during most of the year, there is great potential in energy use reductions to be achieved through behavioral changes in the student population.

- The third and fourth strategies require greater monetary investment in the form of offsets and renewable energy credits. The following three reductions targets provide a basic blueprint for achieving carbon neutrality by the year 2030.

- The following targets are recommended:

  Reductions Target #1: 10 % below FY '08 by 2015: Although this may not appear, on the surface, to be a very aggressive short term target, recall that anticipated campus construction projects during this period are projected to produce an additional 5-10% increase in energy demand. Thus, with this trajectory in mind, the actual mitigation of GHG emissions by 2015 will need to be somewhere in the range of 15-20% in order to meet this goal.

Reductions Target #2: 20% below FY '08 by 2020: The second target continues the steady downward trend in GHG emission by 2% per year on average. At this point, the "low-hanging fruit" of energy conservation measures will likely be exhausted, and the focus will shift toward more renewable energy investments. By 2020, renewable energy should become much more competitive within the overall energy market, making this time period an opportune moment to shift gears.

Reductions Target #3: carbon neutral by 2030: Circumstances of the year 2030, being relatively distant, are difficult to predict. In any case, absolute carbon neutrality is extremely difficult to achieve without the use of offsets. Therefore, offsets will, of necessity, become an important strategy in achieving this target.

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- Recommendations for integrating climate change education into residential education, curriculum, and research are made in Section III.

- Recommendations for funding GHG emissions reductions are provided in Section IV. A diverse selection of funding sources is recommended, with particular emphasis on a revolving loan fund.

- Recommendations for tracking GHG emissions data and progress towards intended goals are covered in Section V. Specific recommendations for improved tracking of air travel miles are emphasized.

Introduction

Requirements of the American College and University Presidents Climate Commitment (ACUPCC)

The accelerating pace of human-influenced climate change and our growing awareness of its negative public-health, environmental, and economic consequences compel decisive action. In recent years, many institutions of higher education have taken leadership roles to promote sustainability and climate neutrality at the campus level. In January 2008, Bucknell University became a signatory to the American Colleges and University Presidents Climate Commitment (ACUPCC). Under this agreement, Bucknell is required to prepare a comprehensive inventory of greenhouse gas emissions by May 2009, to update the inventory every other year thereafter, and to implement tangible emissions-reducing actions in the short-term (two years). The ACUPCC further requires Bucknell to develop a long-term Climate Action Plan (CAP) by May 2010 containing the following information:

i. A target date for achieving climate neutrality (i.e., no net greenhouse gas emissions) 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.

(Source: ACUPCC Implementation Guide)

An additional ACUPCC requirement was the immediate implementation of at least two of seven "tangible actions" to show short-term commitment to reducing greenhouse gas emissions. The tangible actions elected were: **Energy Star appliance purchasing** and **waste minimization**. More details on these actions are available from Dennis Hawley and Dina El-Mogazi, co-chairs of the **Campus Greening Council** (CGC), a sustainability-themed body created by President Mitchell in January of 2008. The CGC is currently composed of a diverse array of faculty, staff, and students (approximately 30 members, see Appendix B) representing different facets of campus academics and operations. The CGC is the official body charged with overseeing the fulfillment of ACUPCC requirements, including the development of a Climate Action Plan. The Council is co-chaired by the Associate Vice President for Facilities and the Director of the Campus Greening Initiative who is a member of the faculty.

The CAP and a Historical Context of Sustainability at Bucknell

Bucknell's historical achievements in the arena of environmental responsibility are well documented. In 2007, the Bucknell University Environmental Center (BUEC) commenced an **Environmental Assessment** addressing several key indicators: university administration and policy, education and research, energy, water, solid waste, hazardous materials, purchasing, dining, the built environment, and landscape. The Assessment involved the joint efforts of more than 70 students, faculty, and administrators and was coordinated through the Campus Greening Initiative of the Bucknell University Environmental Center. The Environmental Assessment, as a process, was a tremendously useful starting point for discussion of campus resources, attitudes, priorities, and suggestions for further improving sustainability at Bucknell. The results from the Assessment form a critical outreach tool that helps share the university's sustainability vision with the broader academic and local community and provides concrete evidence of accomplishments. The document is called "A Comprehensive Environmental Assessment of Bucknell University" (El-Mogazi 2009) and is available online at: http://www.bucknell.edu/Documents/EnvironmentalCenter/Assessment%20Report%20final.pdf

In the specific area of climate change, Bucknell has also made significant progress. Bucknell's first greenhouse gas (GHG) inventory was completed in 2006 with primary groundwork accomplished by students, Environmental Center personnel, and the Facilities Department. In 2008-2009, an update to the greenhouse gas inventory was conducted through a combination of student and Environmental Center efforts. These efforts have produced a remarkable campus-wide inventory of greenhouse gas emissions for a period of nearly **twenty years** (FYs 1990-2008). This dataset is an enormously valuable assessment tool and one that is quite rare for an educational institution. In recent years, as more information is accumulated and technology has improved, specific attention has been directed at energy conservation measures that are discussed in a later section. In January 2008, Bucknell University became a signatory to the American Colleges and University Presidents Climate Commitment (ACUPCC).

How the Climate Action Plan was Developed

The Bucknell CAP was developed collaboratively and in stages. Initially, climate change-relevant data on campus operations were collected by campus sustainability and facilities staff. These data include the greenhouse gas inventory, described further in the following section, as well as collation of results from prior faculty/student research projects, the campus-wide Environmental Assessment, and existing records/documentation from Facilities. Bucknell's CAP has also been shaped by guidance from the Association for the Advancement of Sustainability in Higher Education (AASHE) and from the publicly available examples of CAPs and other innovative approaches developed at other educational institutions. As a final step, feedback from the broader campus community was solicited, first from the thirty-member Campus Greening Council charged with enforcing ACUPCC, and later, from a broader sector of the community.

Placing Carbon within a Broader Mission of Sustainability

The subject of this document is the mitigation of climate warming by reducing the net amount of greenhouse gases emitted by the activities of Bucknell University's students, employees, and facilities. On January 31, 2008, Bucknell pledged to create a timeline for

attaining carbon neutrality by signing the high-visibility ACUPCC. Lest this appear to call for a cerebral number-crunching exercise, the following caveat is noted: while carbon neutrality is a core component of sustainability, and carbon accounting is a thread linking most campus affairs, the goal of reducing Bucknell's carbon footprint should be viewed as a means, not simply an end in itself. The benefits associated with striving toward campus sustainability—minimizing waste, reducing pollution, empowering grassroots change, encouraging transparency and accountability in campus operations, reaching out to community members, and teaching and learning collectively—are all significant and commendable end-goals.

* * *

Section I: Campus GHG Emissions

Bucknell's "Carbon Footprint" (Greenhouse Gas Inventory)

Definition and Scope

Bucknell University Snapshot	
Year Founded:	*1846*
# Students	*3,563*
# Faculty	*358*
# Staff	*1,019*
Built Space (sq ft)	*2.65 M*
Research Budget	*>$1.8 M*
Fiscal Year	*Jul 1 – Jun 30*
% Students Housed	*????*
	FY 2008 Data

A greenhouse gas (GHG) inventory is a dataset that describes net emissions of six greenhouse gases regulated under the Kyoto Protocol: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6). As defined by the ACUPCC, GHG emissions subject to inventory include: **direct emissions** (e.g., from university-owned buildings); **indirect emissions from purchased power** used in university-owned facilities (e.g., emissions produced by an outside provider of electricity); and **indirect emissions** from university-funded activities such as transportation or waste disposal that occur in **non-university-owned settings** (e.g., travel for study and research, commuting). These emissions are known as **Scope 1**, **Scope 2**, and **Scope 3 emissions**, respectively, and are illustrated below (Fig. 1). For uniformity, emissions are converted to CO_2 equivalents, abbreviated as eCO_2, based on their contribution to warming effect, known as the global warming potential (these calculations occur automatically in the emissions calculator software).

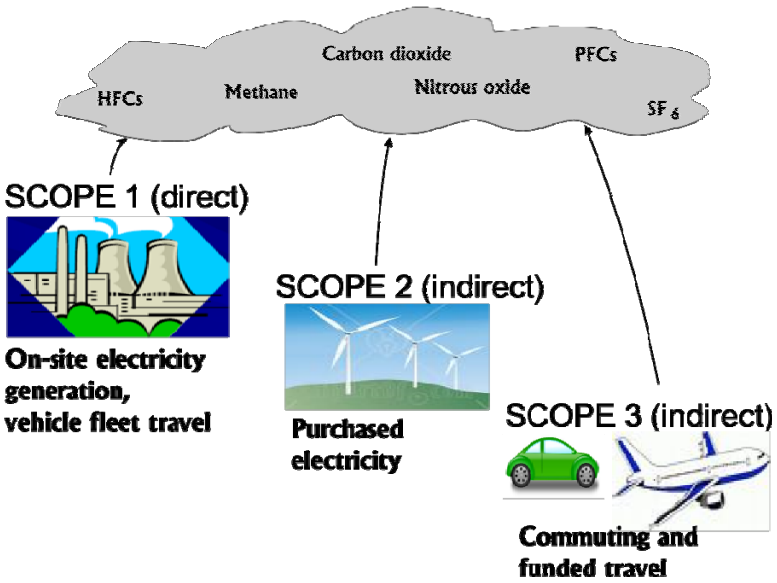


Figure 1. Simplified diagram of direct and indirect sources of greenhouse gases reported under the ACUPCC.

Broadly speaking, the major sources of Bucknell's GHG gross emissions include: steam and electricity generation (co-generation plant), other on-campus stationary sources, university

vehicle fleet, and losses from refrigerants and chemicals (which fall under Scope 1); purchased electricity (Scope 2); and air travel and commuting (Scope 3).

For consistency with other colleges and universities participating in the ACUPCC, Bucknell University's GHG inventory was generated using publicly available Clean Air-Cool Planet (CACP) software and years were defined as the fiscal year (beginning July 1). For more information on inventory methodology, details are provided in Appendix A, "Methodology and Data Sources".

Overview of Emissions Trends

Five main factors have influenced Bucknell's documented emissions: (1) transition to a natural gas-fueled cogeneration plant by FY 1999 (this is the single most important factor); (2) availability of new transportation emissions data[1]; (3) steady campus growth; (4) changes in the purchase of renewable power; and (5) ongoing implementation of energy upgrades by facilities staff. These factors will be discussed further in the following section. Two further observations may be noted regarding the inventory results: throughout the measurement period, the GHG inventory was heavily dominated by CO_2 emissions, with CH_4, N_2O, and CFC-compound emissions comprising a very small proportion of the inventory[2]. Over all years, the major contributing source of CO_2 emissions for the campus was the co-generation facility production of steam and electricity.

Transition to Co-Generation - Combined Heat and Power System (CHP)

- Prior to FY 1999, Bucknell burned coal to produce steam and a small portion of its electricity . By FY 1999, Bucknell had fully transitioned to a more efficient mode, namely a co-generation plant which is primarily fueled by natural gas and to a lesser degree, by No. 2 fuel oil. The on-site co-generation facility provides electricity, steam heat, and chilled water to many of the buildings on campus. Bucknell's CHP is more efficient than other forms of electricity generation, since "waste heat" serves a useful purpose. The system was built at a cost of $12 million, self-financed, with an estimated annual energy savings of about $1.25 million (2003-2006 data).

Features of BU's CHP System

An electricity-generating combustion turbine runs on gas or fuel oil (contributing about 5,000 kW)

- Electricity is also generated by a separate steam turbine mechanically powered by steam as a pressure reduction station (creating about 1,200 kW)
- A "heat recovery steam generator" takes waste heat and helps recycle its energy into steam production (about 25,000 lbs steam/hr), with the remainder of the demand (up to 70,000 lbs steam/hr) supplied through co-firing of the steam generator with natural gas.

[1] As they are not centrally recorded at the present time, commuting and air travel data were manually compiled (see Robertson 2008). They represent a relatively new addition to the GHG inventory.

[2] In 1990, for instance, methane emissions were actually counted as a negative number because of landfill capture, and emissions of nitrous oxide and three CFC-containing compounds represented about 0.1% of the total in each case, respectively.

- Steam is used for on-campus heating (in winter) and for cooling needs via the absorption chiller process (in summer), as well as production of domestic hot water and cooking year round.
- Turbines are run at full capacity, so if electricity demand on campus is temporarily low, electricity generated in excess of needs can be sold back to the grid.
- In the summer, less fuel is burned for heating purposes, so electricity demand may exceed the amount of electricity produced by the CHP. At these times, electricity supply is typically supplemented with externally purchased sources (wind energy).
- Because steam is the primary product of the CHP, finding ways to reduce demand for heating and especially cooling (because cooling consumes more fuel per degree of temperature change) may be particularly important in reducing emissions from the CHP.

Importantly, the transition to cleaner-burning natural gas and the greater efficiency of the CHP dramatically reduced the gross (pre-offsets) GHG emissions from approximately **65,600** (in 1990) to **38,800** MTCE (in 2000), roughly a 41% decrease in gross emissions (Fig. 2).

The amount of purchased electricity has also been greatly affected by the switch to cogeneration. In 1990, for instance, Bucknell's coal-fired plant produced roughly 56 % of total emissions, with purchased electricity making up much of the difference (Fig. 3). By FY 2004, the co-generation plant was responsible for about **87 %** of gross emissions on campus (Kassab 2006). The most recent data shows that 95% of Bucknell's total energy consumption is now supplied by natural gas, with the remaining 5 % of energy supplied by No. 2 fuel oil, propane, and purchased electricity (El-Mogazi 2009). Certain GHG emissions are a product of the transmission and distribution (T&D) of electricity from the grid to the end user; thus, because these "T&D losses" scale with the amount of purchased electricity, they comprise a much smaller proportion of the GHG inventory in recent years. In summary, the establishment of the co-generation facility has given Bucknell greater control over its emissions, control which the university has used to select a relatively clean type of fuel, natural gas.

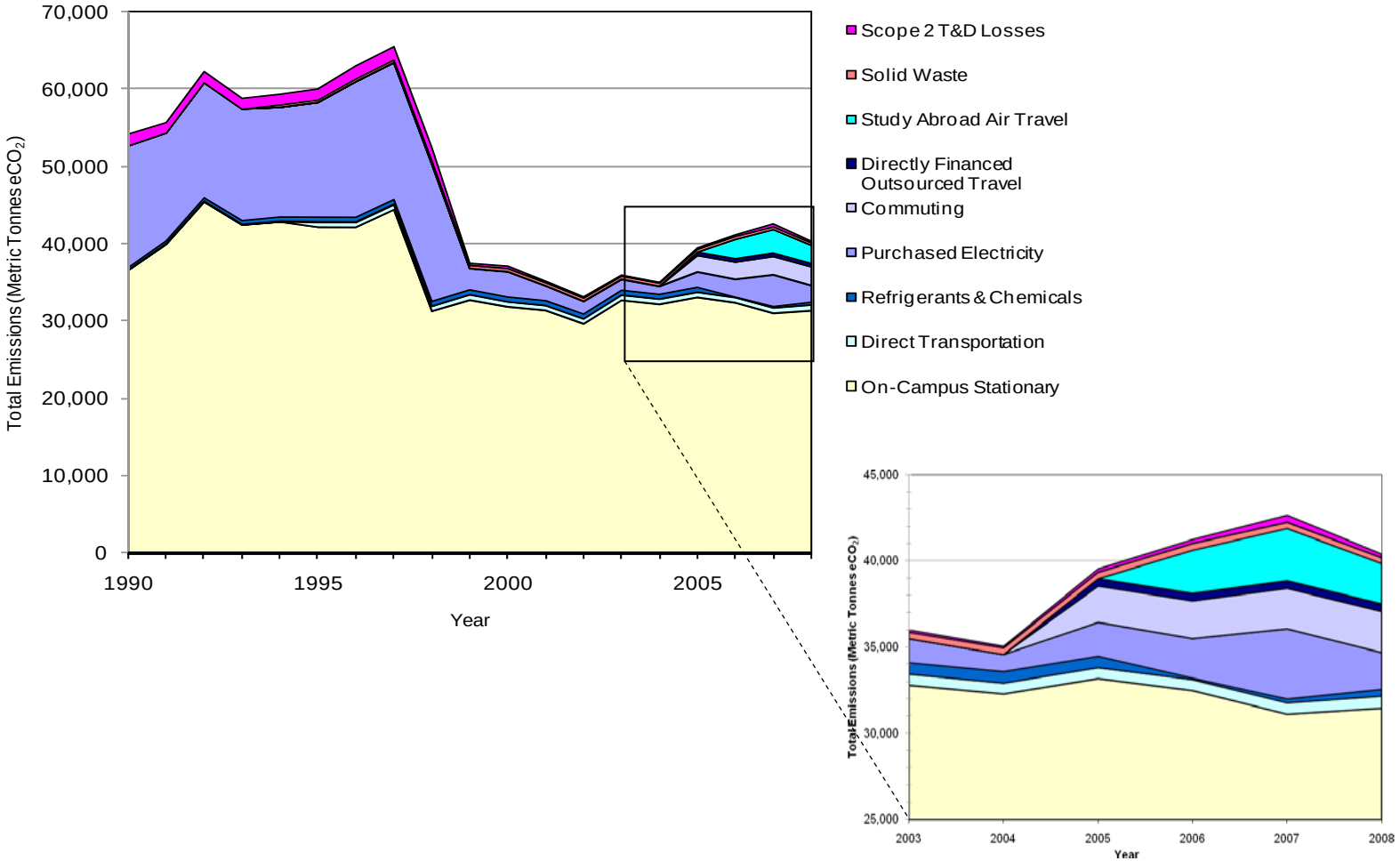


Figure 2. Total emissions at Bucknell characterized by source. The largest source is "on-campus stationary," then "purchased electricity". Inset figure at lower right shows expanded view of more recent data. Note: 1996-1997 data are approximated because data were incomplete during the transition from coal to CHP.

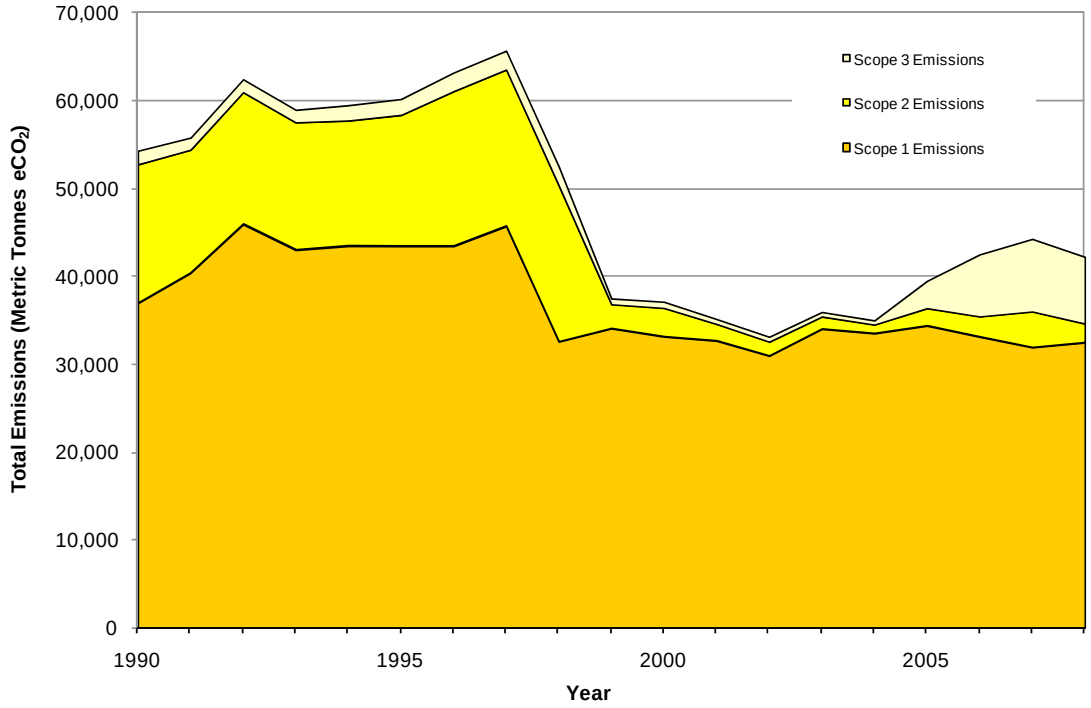


Figure 3. Total emissions at Bucknell, categorized by Scope. Note: 1996-1997 data are approximated because data were incomplete during the transition from coal to CHP.

Expansion of Transportation Dataset

As shown in Figure 2, transportation emissions emerge from many sources from Scope 1 (university-owned vehicle fleet, also known as "direct transportation") and from Scope 3 (commuting, air travel by students studying abroad, and "directly financed outsourced travel" or DFOT). The nature of air travel is such that its emissions typically have greater warming impact than emissions from ground-based transportation, both because the travel occurs over greater distance (e.g. international air travel) and because the emissions occur higher in the atmosphere, where they have greater effect (CA-CP). The DFOT category includes both travel conducted by faculty/staff to perform research or accomplish university business and travel by student athletes. In the case of faculty/staff travel, a portion of this travel is done using an official university travel service/expense account, while some travel is done using personal funds that are then reimbursed by the university. Unfortunately, prior to the ACUPCC, there was little explicit documentation of (and no centralized reporting structure for) Scope 3 travel categories. The emissions from reimbursed DFOT by faculty/staff are especially poorly documented and thus omitted at the present time[3]. The DFOT breakdown, according to our most recent (but acknowledged to be incomplete) records is roughly 40 % from athletics travel and 60 % from faculty/staff centrally-purchased air travel (average of 3 years of data). Ground-based travel within

[3] Note that collection of these data will be improved in the future, probably by means of a travel survey as has been done at other institutions.

DFOT is also largely not documented at this time, but is assumed to have less weight than air travel, so air travel will be the focus of this category.

The GHG inventory graph shows the emergence of air travel data (turquoise color for study abroad, dark navy color for DFOT) beginning in FY 2006 (Fig. 2). This change reflects the painstaking manual compilation and calculation of these data according to a specific protocol in the most recent GHG inventory update (Robertson 2008). In addition, FYs 2006 – 2008 include new student and faculty/staff commuting data (process also described in Robertson 2008). These newly catalogued sources give the appearance of significant increases in Scope 3 emissions as a proportion of the total inventory. For comparison, Scope 3 emissions accounted for less than 5% of the GHG inventory in the period 1999 - 2004; but in 2006 and 2008 Scope 3 emissions rose to between 20 and 30% (Fig. 3). **However, rather than interpreting these as a change in activities, these data should be viewed as an improvement in reporting.** Of the Scope 3 sources, air travel (the sum of DFOT and study abroad) remains the most significant contributor, at 10%, while commuting is not far behind, comprising about 7% of the inventory (Fig. 4, Table 1). Table 1 helps to clarify the discussion of appropriate mitigation strategies in a later section, as the areas with greatest potential for emissions reductions tend to be the categories with the largest sources currently.

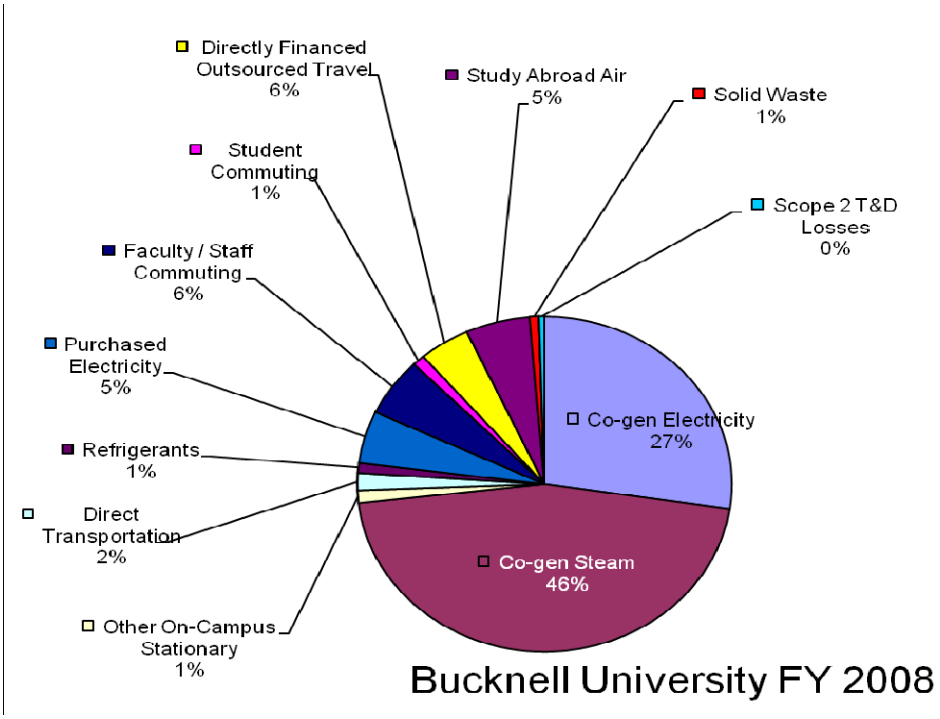


Fig. 4 Breakdown of gross campus GHG emissions for FY 2008.

Table 1. Bucknell FY 2008 GHG gross emissions data by source, arranged in decreasing order

Category	eCO_2 (Metric tons)	% of Inventory	Scope
Co-gen (steam)	19,379.0	46	1
Co-gen (electric)	11,561.0	27	1
Air travel*	4,205.1	10	3
Fac/Staff Commuting	2,379.9	6	3
Purchased electricity	2,131.9	5	2
Univ vehicle fleet	701.4	2	1
Other on-campus stationary	508.9	1	1
Student commuting	446.5	1	3
Refrigerants leakage	406.9	1	1
Solid waste	336.3	<1	3
Purchased electricity T & D Losses†	210.8	<1	2
TOTAL (gross emissions)	42,267.7	100	--

* Air travel is comprised of directly financed outsourced travel (which includes athletics) and study abroad travel.

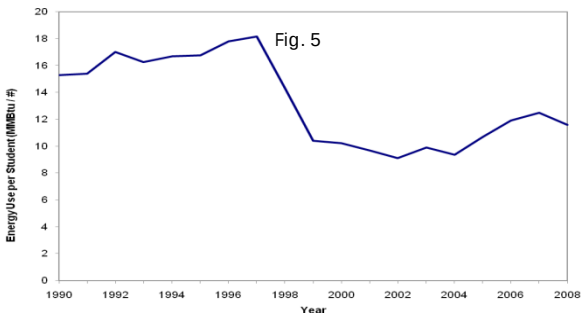
† Refers to transmission and distribution

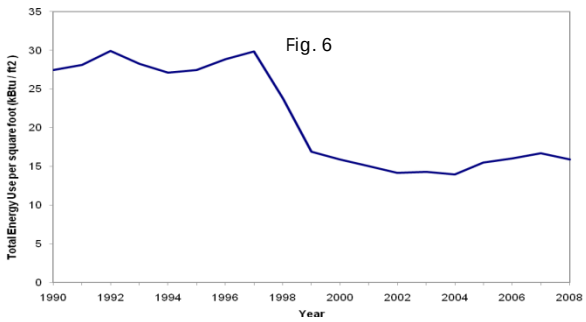
Trends in Demographics and Built Space

This section will present energy use and emissions normalized through the two measures recommended by ACUPCC: size of the full-time student body[4] and area of built space.

The full-time student body at Bucknell has hovered consistently close to 3500 students over the period 1990 - 2008. Energy use per student over this time period dipped with the conversion from coal to CHP and remained fairly constant afterward, excepting a slight upward trend reflecting increased data coverage (e.g., transportation emissions) (Fig. 5).

In the early 2000's Bucknell experienced significant campus expansion (upwards of 300,000 GSF). Additions included a 300-bed student dormitory (McDonnell Hall, 2000), three academic buildings (Weis Music 2000, Breakiron 2004, and the O'Leary Center 2002, and several recreational facilities (Langone Athletics and Recreation Center, Sojka Pavilion, and Kinney Natatorium, 2002 – 2003). Despite these growth trends, energy usage (in





MMBtu) per 1000 GSF of built space has held relatively steady from FY 1998 to 2008 (Fig. 6). This encouraging evidence suggests that infrastructure-related conservation measures have helped limit energy consumption, especially given that the more recent data includes sources (e.g. air travel) that were not counted before.

Renewable Energy

Renewable energy is a small but important component of Bucknell's energy mix. The Environmental Assessment Energy Team (El-Mogazi 2009) reported that electricity purchased from the grid—representing roughly 3% of campus energy use—was 100% renewable as of January 2008[5]. Since 2005, Bucknell has obtained RECs (renewable energy credits) for its purchased wind power. The amount of renewable energy purchased has grown significantly: Bucknell purchased 1 million kWh of wind power annually from 2003 to 2008 (reducing total emissions by approximately 650 MTCE per year, and 2.5 million kWh--equivalent to 19,000 MMBtu in terms of energy supply) in FY 2008. These changes, it should be noted, are <u>not</u> reflected in Bucknell's gross emissions, but in its **net emissions**, counted after taking offsets into account. (Bucknell increased wind power purchases in 2009 to 4 million kWh.)

As for on-site renewable energy, three sets of photovoltaic panels have been installed since August 2006, but these account for a very small percentage of the campus' energy supply (essentially negligible on the order of the whole inventory). However, it should be noted that there are pilot or exploratory studies in progress looking at such energy sources as on-site wind and on-site geothermal[6]. More information on these options should be available over the next few years.

Ongoing Energy Conservation Measures

According to the Energy Team (created 2007) which consists of facilities personnel, seven capital projects aimed at improving energy efficiency are currently active (these are summarized in Appendix B). The main goal of these ongoing improvements is to maintain a 2% per year decrease in total energy consumption over the next five years. Examples of successfully completed modifications in recent months include the upgrading of the chilled and hot water pumping system in the Rooke Chemistry building from constant to variable flow (a cost of $ 75,000 with an estimated annual savings of $ 20,000), the upgrading of the Langone Center's main serving area hoods (cost: $125,000, expected annual savings: $ 20,000), and lighting upgrades across campus (e.g., T8-T12 upgrades in academic buildings, costing $24/fixture at an estimated annual savings of $60,000[7]). Efforts also continue toward the auditing and monitoring of certain energy intensive buildings.

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[4] To conform with ACUPCC norms, the denominator includes students only, not faculty and staff. This simplification differentiates the "per-student" ratio from a "per-capita" calculation which would include faculty/staff (and thus, would be a smaller number).

[5] Increases enacted during calendar year 2009 will not be fully reflected until FY 2010.

[6] The geothermal project would be sited on a 50-acre farm tract owned by Bucknell. The project would be used to alleviate heating and cooling needs for new buildings.

[7] This estimate assumes 10 h/day usage and a 168 kW difference between T8 and T12.

How Do Bucknell's Emissions Compare to Other Colleges & Universities?

For ACUPCC signatories, synthesized data are available by "Carnegie classification" (which degrees are granted). Bucknell is classified as "Bac/A&S: Baccalaureate Colleges—Arts & Sciences". For this category, the **average** data are as follows (sample size = 89 schools, data subject to change, accessed on 04/03/09, Table 2):

Table 2. Baccalaureate College Emissions Data (Source: Online ACUPCC Reporting System, "Statistics and Data Views")

Emissions Category	MTCE/1000 ft^2	% of total gross emissions
Scope 1	4.55	31 %
Scope 2	7.2	49 %
Scope 3	3.05	21 %
Total	**14.81**	100 %

Data were also obtained for the Master's Colleges and Universities category (sample size = 89 schools, data subject to change, accessed on 04/03/09, Table 3).

Table 3. Master's College/University Emissions Data (Source: Online ACUPCC Reporting System, "Statistics and Data Views")

Emissions Category	MTCE/1000 ft^2	% of total gross emissions
Scope 1	3.88	24 %
Scope 2	6.74	42 %
Scope 3	5.32	33 %
Total	**15.93**	100 %

Comparison Table: Specific Peer Institutions

What is being assessed in Table 6 below?

Net values include offsets, but gross values do not. If multiple years of data were available, the two most recent years were selected. Data are given, wherever possible, in total metric tonnes, tonnes per 1000 square feet, and tonnes per capita (as defined by ACUPCC as tonnes per full-time enrolled student). If individual scope data are available they are listed, otherwise "1,2,3" indicates that these values were lumped together. Values reported are not taken from graphs or visual display items but are actual numbers quoted by the institution in some official capacity. For signatories to the ACUPCC, the ACUPCC website is the primary data source; for non-signatories, a source is noted. Years refer to fiscal years beginning July 1 (of the previous calendar year) unless otherwise noted. Most institutions used the CACP calculator; exceptions are noted.

Table 4. Published Greenhouse Gas Emissions from Bucknell and Peer Institutions

School	Scope(s)	Year	MTCE	MTCE "per capita"	MTCE/1000 ft²	Notes
Bucknell*[8]	1 (gross)	2008	32,557	9.1	12.3	
	2 (gross)		2,132	0.6	0.8	
	3 (gross)		7,579	2.1	2.9	
	1,2,3 (gross)		42,268	11.8	16.0	
	1,2,3 (net)		41,647	11.4	15.3	
Carleton	1,2,3(gross)	2007	21,533	10.8	11.9	Calendar yr 2007
	1,2,3 (net)		21,533	10.8	11.9	
Middlebury	1,2,3(gross)	2007	31,200	12.5	12.5	
	1,2,3 (net)		29,882	12	12	
Oberlin	1,2,3(gross)	2007	51,049	18.6	19.3	Calendar yr 2007
	1,2,3 (net)		40,442	14.7	15.3	
Williams†	1,2,3 (net)	2007	22,800	n/a	n/a	
	1,2,3 (net)	2006	29,700			
Smith	1,2,3 (gross)	2007	31,491	10.3	10	
	1,2,3 (net)		30,978	10.2	9.8	
Bowdoin	1,2,3 (gross)	2008	24,557	14.4	12.5	custom calculator
	1,2,3 (net)		17,166	10	8.8	
Davidson	1,2,3 (gross)	2008	23,387	14	14.9	
	1,2,3 (net)		23,387	14	14.9	

*Source: GHG08 (Robertson, 2009, finalized by El-Mogazi on 5/14/09)

†Source: http://blogs.williams.edu/sustainability/2008/01/15/report-on-greenhouse-gas-emissions-during-fiscal-year-2007

Because many subtleties cannot be accounted for in this brief table, such as whether institutions completely and accurately reported input data from all categories, readers are advised to use this information only as a general indicator; the ACUPCC website contains the following caveat: "Making fair comparisons between higher education institutions is always challenging.... The unverified nature of the information in this database and unavailability of unbiased normalization metrics means such comparisons are even more difficult. Users should therefore approach direct institution to institution comparisons with caution and recognize that all comparisons between institutions are inherently biased."

[8] Bucknell's total building space was approximately 2.65 million sq ft in 2005 and as of spring 2009, has not increased measurably since then (personal communication, Dennis Hawley); in FY 08 there were 3,563 enrolled students, assumption is that all are FTE.

Institutions are expected to report *de minimis* emissions (those deemed trivial for being less than 5% of the total) that may have been omitted from the GHG inventory. If an institution provides reasonable justification as to why the omitted emissions should be lower than 5%, this information was accepted. Included below is information where the selected institutions either provided no data/explanation, or inadequate justification.

[Bucknell's *de minimis* emissions are discussed earlier in this section.]
Carleton: Emissions from off-campus business use of vehicles were undetermined.
Middlebury: Fugitive emissions from refrigerants were not determined.
Oberlin: no information provided.
Williams: no information provided.

As of May 2009, Bucknell's data indicate that it is close to the average in terms of per capita emissions and emissions per 1000 sq ft. There are some unanswered questions raised, such as: Are the numbers being compared all equivalent metrics? Does Bucknell's status as a master's granting university affect to which institutions it should rightfully be compared? Are regional environmental conditions, such as use of air conditioning/heating accounted for? What percentage of students reside in on-campus housing included in the inventories? As mentioned earlier, faculty and staff contribute to campus emissions, but do not count toward the "per capita" ratio which is based solely on number of full-time students. In general, however, it points to plenty of room for improved mitigation of greenhouse gas emissions.

Projections in Emissions and Energy Use under Future Growth

Business as Usual

This section examines the five above factors within the context of the university's future outlook, under a typical "business as usual" (i.e., no further climate change mitigation) approach. This section will assess, at a necessarily coarse scale, how campus growth will translate into adjustments in emissions and energy use. Bucknell's Master Plan includes the expansion of academic building space to resolve the current shortfall of classroom space as well as replacing some off-campus apartment housing with a new dormitory complex. Clearly, factors aside from the major ones discussed below may exist, but are beyond the scope of this section.

Central power plant: No changes in CHP functionality are planned at the present time. Currently, the plant operates at maximum capacity for electric production over certain intervals, necessitating the outside purchase of electricity during peak demand. If the increase in built space causes new energy demand to exceed new conservation measures, there will be an increase in the campus's reliance on purchased power, likely raising the cost of energy.

Transportation data: Increased reporting of transportation-related emissions which were previously overlooked will likely cause an overall increase to campus emissions on paper. A special category of concern is DFOT, including personal/reimbursed travel by faculty/staff. Note that this will not represent new behavior, only new reporting.

Demographics/built space: No large changes are expected in terms of student enrollment. However, by 2013 new buildings[9] will increase the total area of built space on campus and necessitate increased energy consumption and GHG emissions. Expectations are for a new academic complex of 65,000 gross square feet (GSF) plus 130,000 GSF of new residential housing. The following assumptions were used for forecasting purposes:

- An appropriate energy benchmark for new construction would be 165,000 BTUs per GSF per year, thus contributing at minimum (need to recalculate)MMBtus per year (where MMBtu = million BTUs).
- A rough "emission factor" for natural gas burned by the CHP (as calculated in Bucknell's emissions profile) is approximately 52.8 kg CO_2 / MMBtu (equivalent to 0.0528 eCO_2 / MMBtu).
- By 2013, the additional built space would increase emissions by roughly (recalculate) 1600 MT eCO_2, representing an increase from the FY 2008 inventory of at least **3.9 %**.
- A new Arts building and another academic complex (Academic East) are slated for construction by 2015, together increasing built space by about 90,000 to 100,000 GSF. Using similar assumptions as above, energy demand would rise by at least 16,500 MMBtu, raising emissions by at least 870 MT eCO_2, about **2 %**.

It is quite important to note that the new housing will accommodate many students who currently reside off-campus where their emissions are not included in the campus total. As with the example of transportation data, this increase in data coverage will help resolve the undesirable situation of genuine emissions which go under-reported[10].

Renewables. The "business as usual" scenario already includes purchase of 100% renewable energy when required. The campus lacks on-site renewable power, but absent any major plans to overhaul campus infrastructure, we assume here that on-site renewable energy will continue to play a limited role in the overall campus budget. Divergence from business-as-usual will be discussed in a later section as part of a "mitigation strategy".

Ongoing conservation. The business-as-usual scenario includes the assumed **2%** per year decrease in energy consumption across campus, related to building infrastructure renovations and improvements, totaling 10% by 2012. Conservation above this assumed baseline is discussed in the mitigation strategies section.

Summary. Under the business-as-usual scenario, increased data coverage of transportation (especially DFOT), augmented built space, and inclusion of some previously hidden emissions from off-campus residences, are likely to increase overall campus emissions in the range of **5-10% above** FY 2008 levels by 2015.

[9] In addition, two fraternity houses will be completely replaced by 2013. The energy consequences of this are unknown, but include a balance of likely efficiency improvements and inclusion of previously unrecorded emissions. For this document, we assume an overall null effect.

[10] About 500 students live in off-campus apartments and roughly half of these would be accommodated by the new housing.

Section II: Greenhouse Gas Reduction Targets and Mitigation Strategies to Reduce GHG Emissions

Mitigation: Strategies and Specific Tactics

This section moves us away from "business-as-usual" and toward mitigation (actions to reduce the campus carbon footprint). We will consider several mitigation *strategies* which set certain emissions reductions targets, then examine specific *tactics* that could be employed to achieve these targets.

Maximizing Impact

The three largest sources of GHG emissions are also the areas where mitigation will have the largest potential impact: **steam generation, electricity generation, and air travel** (Table 2 shows the relative benefits of reducing each of these emissions sources by 10%). In recognition of these facts, four logical strategies for reducing GHG emissions in the short term would be:

- reducing demand for fossil fuel-based heating/cooling (representing steam production),
- reducing demand for electricity,
- minimizing emissions from purchased electricity , and
- reducing emissions from air travel.

Table 5. Mitigation Targets (referencing FY 2008 values)

Category	eCO_2 (Metric tons)	% of Inventory	ΔeCO_2 Saved (10% Reduction)
Steam	19,379.0	46	1,937.9
Electricity†	13,692.9	32	1,369.3
Air travel *	4,205.1	10	420.5
Commuting (Student, Fac/Staff)	2,826.4	7	282.6
Univ vehicle fleet	701.4	2	70.1

†Combination of on-site CHP and purchased electricity.

*Sum of DFOT plus study abroad travel.

N. B. Four smallest categories (sum of emissions < 3 %) were removed per the *de minimis* criterion.

As Table 2 shows, combining heating/cooling and electricity essentially means that roughly 78 % of Bucknell's inventory is related to **energy use in buildings** (note that electricity can be further divided into appliances/equipment or lighting uses). Thus, if cuts can be made in these emissions, a larger impact will be felt in the overall inventory. The significance of buildings in the campus energy footprint is further demonstrated by the oscillating pattern of monthly historical energy use, showing peak use in winter months (when day length is shorter and temperatures are lower; Figure 7). Somewhat surprisingly, a constant "baseline" value of over 40,000 MMBtu/month is also evident in this figure, even in summer months when the student population is greatly reduced. Identifying the status quo by making

available this type of transparent and temporally detailed monitoring data will help in the appropriate design and implementation of energy conservation strategies. Air travel is another significant use category, although as mentioned above, data for this category is less well documented.

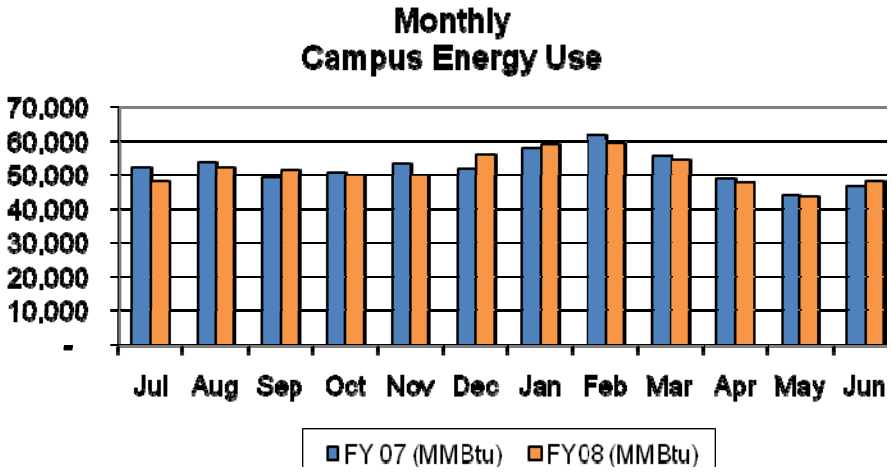

Figure 7. Seasonal variation of campus energy use as shown in two representative years, FYs 2007 and 2008. Source: Annual Energy Report FY '08, Facilities Energy Team.

The first two strategies could be addressed most effectively in the short run through two broad-based tactics: The first would be to hire, within the Bucknell Facilities, an "Energy Manager" whose overall objective would be to identify and implement specific energy conservation initiatives within the university's operations. According to Dennis Hawley, Associate Vice President for Facilities, such a position would likely pay for itself within a year's time, given the high cost of energy. This type of position has been implemented successfully at other schools such as neighboring Dickinson College, where very significant energy reductions and cost savings have been achieved simply by powering down buildings and equipment when it is not in use.

The second broad-based tactic for short term energy conservation would involve the implementation of a residential sustainability education program in Bucknell's residence halls. Because the bulk of Bucknell's population is students, and because the vast majority of these students live on campus 24-hours, 7 days per week during most of the year, there is great potential in energy use reductions to be achieved through behavioral changes in the student population.

The third and fourth strategies require greater monetary investment in the form of offsets and renewable energy credits. The following three reductions targets provide a basic blueprint for achieving carbon neutrality by the year 2030. For a graphic representation of these targets, see Figure 8 below.

Reductions Target #1: 10 % below FY '08 by 2015

Although this may not appear, on the surface, to be a very aggressive short term target, recall that anticipated campus construction projects during this period are projected to

produce an additional 5-10% increase in energy demand. Thus, with this trajectory in mind, the actual mitigation of GHG emissions by 2015 will need to be somewhere in the range of 15-20% in order to meet this goal.

Under the "10 % reduction" target, Table 2 indicates the amount of CO_2 equivalents that would be saved if each category were reduced from its FY 2008 values. (FY 2008 values are used in this case because 2008 represents the year with the most complete data set for all three scopes of GHG emissions.) The first two values in this column are associated with energy use in buildings.

At a broad level, several **strategies** could be used to attain the 10 % reduction target, including:

- energy conservation (elimination of unnecessary use, reducing redundancy)
- efficiency improvements (upgrades, retrofits, new technology)
- continued use of renewable energy credits to offset any purchased electricity
- purchased offsets for air travel, up to 50% of total air travel emissions, as needed to achieve the overall 10% greenhouse gas emissions reduction goal.

Specific tactics or projects which might be used to attain the 10 % reduction target are summarized below in a manner that indicates the "responsibility" category of each tactic (Table 3) as well as the associated estimated costs and benefits. In the "maintenance cost or savings" column, note that most of these tactics provide savings over time. The particulars of energy savings investment strategies would best be determined by a staff member dedicated to energy savings analysis (i.e. the "Energy Manager" mentioned above.) A significant effort in residential sustainability education would also be necessary to achieve energy savings based on behavioral changes, and would provide an important complement to the Energy Manager's efforts.

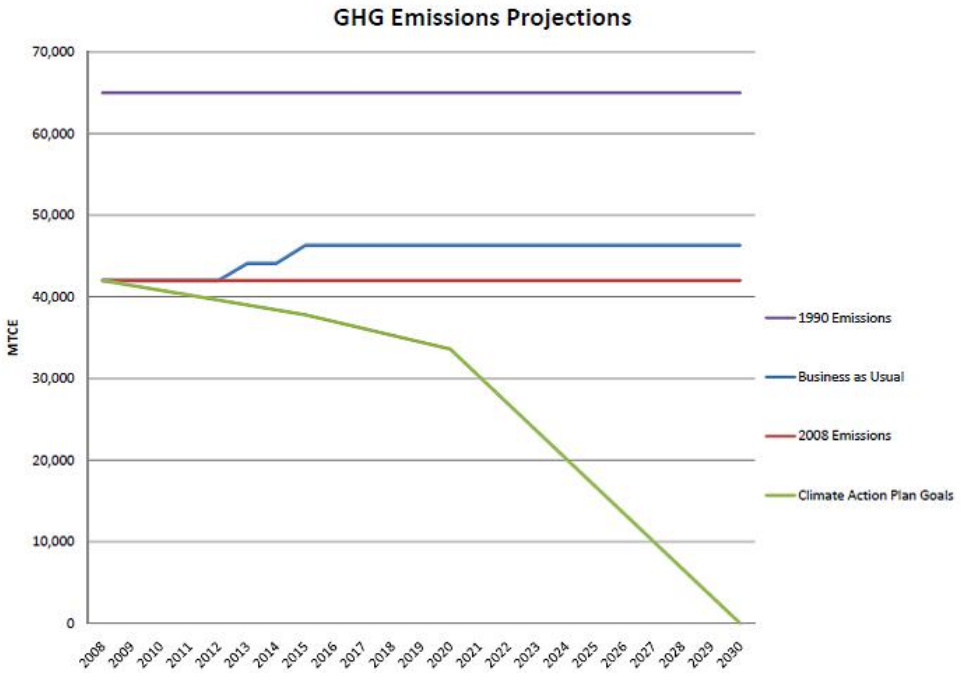

Figure 8. A graphic representation of Bucknell's GHG reductions targets.

Reductions Target #2: 20% below FY '08 by 2020

The second target continues the steady downward trend in GHG emission by 2% per year on average. At this point, the "low-hanging fruit" of energy conservation measures will likely be exhausted, and the focus will shift toward more renewable energy investments. By 2020, renewable energy should become much more competitive within the overall energy market, making this time period an opportune moment to shift gears. At this point renewable energy might be incorporated into Bucknell's overall energy strategy in three basic ways:

- as biofuel introduced into the Co-gen plant in place of fossil-fuel-derived natural gas.
- as larger scale renewable energy projects on campus, such as a solar photovoltaic "farm", extensive solar hot water technology, geothermal applications or as renewable energy credits.

Reductions Target #3: carbon neutral by 2030

Circumstances of the year 2030, being relatively distant, are difficult to predict at this point. Broadly speaking, in order to preserve quality of life for the global human population, as well as biodiversity in the non-human population, global reductions need to proceed at an accelerated pace. Commonly, governmental and institutional targets have been set at 80% reduction in GHG emissions by 2050. However, this is not a particularly aggressive target for an institution of higher learning. Given that colleges and universities are progressive and experimental in nature, and strongly focused on the well-being of young people who will disproportionately bear the burden of effects of global climate change, it makes sense to accelerate this target in comparison to other types of institutions. That being said, the flexible nature of the CAP document leaves room for adjustment in long term goals, depending on the circumstances.

By 2030, there will certainly still be a need to heat, cool and provide electricity to support the campus mission, and it is likely that by this time all of the "low hanging fruit" of energy conservation measures has been fully exploited. The two main options remaining will be investment in renewable energy and/or GHG emissions offsets. New technologies, such as reducing emissions through carbon capture, will also need to play a role in achieving carbon neutrality. As mentioned above, renewable energy is likely to become more competitive with fossil fuels as time goes on. Conversely, offsets will likely increase in cost over time, as GHG regulations, Cap-and-Trade legislation, etc. become more common in our regulatory system. Therefore it is recommended that full scale purchases of offsets for the purpose of reaching carbon neutrality be postponed as long as possible, deferring first to conservation measures and renewable energy investment.

Energy conservation measures to reduce GHG emissions (Table 3)

Responsibility Category	Project	Initial cost	Maintenance cost or savings
Infrastructure	Install occupancy sensors in classrooms	Medium	Savings
Behavior	Turning off lights in unused	None	Savings

	academic buildings at night		
Infrastructure	Delamping (where lighting is currently excessive)	Low	Savings
Infrastructure	Improved auto timer settings so lights are not used where daylight is sufficient	Medium	Savings
Infrastructure	Use of LEDs in outdoor lighting	Med-high	Savings
Behavior	Reduce "vampire" consumption from appliances not in use	Low	Savings
Administrative	Requiring minimum efficiency standards (similar to Energy Star) of personal appliances used by fac/staff/students	TBD	Savings
Behavior	Encourage line drying of laundry	Low	Savings
Infrastructure	Install auto-control lighting in day-use classrooms	Medium	Savings
Infrastructure	Replace heat pump system in Dana Engineering	High	Savings
Infrastructure	Replace outdoor lighting fixtures with LEDs	Medium	Savings
Infrastructure	Academic spaces receive less heating/cooling during nighttime (non-use) hours	Low	Savings
Infrastructure + Administrative	Establish task force on laboratory energy use and best practices	Low	Savings
Infrastructure	Where lighting must be on 24 hours/day, reduce intensity or number of lights	Medium	Savings
Infrastructure	Energy monitoring improvements	Medium	Savings
Infrastructure	Hibernate networked computers when not in use	Low	Savings
Behavior change	Dorm energy use competition	Low	Savings
Behavior change	Students shut down personal computers when not in use	Low	Savings
Behavior change	Establish responsible protocol for adjusting climate control in dorms	Low	Savings
Behavior change	Replace some air travel with ground travel or tele-conferencing	Low	Savings
Administrative + Behavior change	Unplug all appliances during fall, winter, and spring breaks (apply fines)	Low	Savings
Behavior change	Energy Star appliances for students and staff	Low	Savings

Behavior change	Education, Eco reps	Medium	Savings
Administrative + Behavior change	Fac/staff carpooling incentives program	Low to medium	Neutral
Administrative + Behavior change	Restrict student parking to campus periphery to reduce casual commuting	Low to medium	Neutral
Administrative + Behavior change	Incentives for alternative commuting	Medium	Neutral
Administrative	Purchase offsets for air travel	Medium	Cost
Administrative	Renewable Energy Credits for purchased electricity	Medium	Cost
Renewables	Solar electric, solar thermal, wind, etc	High in short term, more favorable in long term	Savings
Renewables	Purchasing biogenic fuels	High in short term, more favorable in long term	TBD

The following timeline may be helpful in visualizing the major milestones and activities associated with the three major GHG reduction targets provided above:

Timeline for progress toward specific GHG emissions reductions.

Year (Month)	Activity or Milestone	Associated Cost
1999	Cogeneration facility established; Bucknell emissions 40% below 1990 levels.	$ 13 million
2009 (May)	FY 2008 GHG inventory completed; recommendations on CAP submitted for feedback (this document)	
2010 May	Final CAP submitted	
2011	Hire Energy Manager	$100 K (salary +benefits)
2012	Residential sustainability education program established	Minimal if existing staff are used.
2013	New green buildings opening	Cost premiums for LEED silver buildings are now virtually negligible, especially where energy savings are factored in
2015	Reduce total greenhouse gas emissions 10 % (from 2008 values) via conservation tactics.	Savings of $ 600 K based on 2008 energy costs.
2015	Purchase offsets for 50% university-sponsored air travel.	Approximately $20 K based on 2008 prices and emissions data.
2020	Switch over 10 % of current cogeneration facility fuel to renewable fuels such as biofuels or biologically-generated natural gas, or	Biofuels compatible with the Co-gen facility are not currently available in this region. Renewable Energy Credits

	purchase equivalent Renewable Energy Credits.	currently carry a premium which is projected to escalate substantially.
2020	Purchase offsets for 100% university-sponsored air travel.	Approximately $20 K based on 2008 prices and emissions data.
2030	Cogeneration facility fuels will be composed of 30% renewable fuels, or purchase equivalent Renewable Energy Credits.	Biofuels compatible with the Co-gen facility are not currently available in this region. Renewable Energy Credits currently carry a premium which is projected to escalate substantially.
2030	Because new construction will be held to greener standards and old buildings will be retired, achieve additional 5 % reduction in total energy budget.	Yearly cost savings from energy and water-efficient green buildings are expected to be highly favorable by this date.
2030	Proposed target for carbon neutrality	Additional RECs and offsets will likely be required. Cost unknown.

KEY
Conservation/Efficiency
New construction
Renewable energy
Offsets

Section III: Education, Research, and Outreach Opportunities

This section addresses the existing climate change emphases present in Bucknell's academic, research, and community outreach programs, and proposes areas for further growth and development.

Educational Activities with Climate Change Emphases

Existing Programs and Activities

Broadly speaking, Bucknell is already engaged in many different educational activities on campus, not all of which are confined to the classroom. Items mentioned here briefly review some key points from the 2009 Comprehensive Environmental Assessment, edited by D. El-Mogazi, which provides a much more exhaustive treatment of this topic (see Chapter 2, pp. 25-35).

Bucknell provides two degree programs with a major environmental focus: Environmental Studies, and Civil and Environmental Engineering. In addition, the Biology and Geology Departments feature degree tracks with environmental components. At this time, there are no degree programs that formally emphasize, or contain a "track" tailored to, climate change. In a recent change, however, Bucknell's School of Management proposed a "Managing for Sustainability" track (under construction, expected to have 20-30 students beginning in academic year 2010-11).[11]

As explained in the Education section of the Environmental Assessment, the University Curriculum was modified in the academic year 2008-2009 to add a universal course requirement called "Environmental Connections" (replacing a former requirement called "Natural and Fabricated Worlds", perceived by many as inadequate). The new requirement emphasizes connecting students to the natural world through personal experience. Eligible courses can emerge from environmental science, the humanities, and social sciences. This course requirement could be an asset in fostering an improved sense of "environmental literacy" on campus (see later discussion in this section). Clearly this broad requirement is much larger in scope than just climate change.

For the purposes of the Environmental Assessment, members of the Education Team identified courses with a significant sustainability component (see Appendix V of the Environmental Assessment Report). For the purposes of understanding how Bucknell's academic offerings address climate change specifically, this list of courses was further narrowed to identify climate change-relevant courses. The decision process was a highly subjective one. Errors in judgment may stem from several causes: for instance, a portion of a class may be highly relevant, but not the course overall. It is likely that some relevant courses are omitted and some of the listed courses may be slightly tangential. The diversity of the courses listed below suggests that students interested in climate change have a wide array of relevant course options housed in several departments.

[11] More detail on these tracks can be found in the Environmental Assessment (El-Mogazi 2009).

Selected List of Climate Change-Relevant Courses at Bucknell (selected by W. Chou from the list provided in Appendix V of the Environmental Assessment)

Department	Course Name
Anthropology	Anthropological Perspectives on Human-Environment Relations
Capstone	Politics and Economics of International Environmental Aid
CE Engineering	Environmental Engineering
CE Engineering	Introduction to Urban and Regional Planning
CE Engineering	Environmental Geotechnology
Chem Engineering	Green Engineering
Chemistry	Introduction to Environmental Chemistry
Chemistry	Atmospheric Chemistry and Physics
Economics	Resources and the Environment
Economics	Political Economy of Global Resources
Economics	Intermediate Political Economy
Env Studies	Introduction to Environmental Studies
Env Studies	Green Utopias
Env Studies	Environmental Pollution and Control
Env Studies	Environmental Planning
Env Studies	Introduction to Ecology Design
Env Studies	Environmental Politics and Policy
Env Studies	Environmental Law
Env Studies	Environmental Science and Public Policy
Geography	From Earth to Home
Geography	Geographies of Globalization
Geography	World Environmental Systems
Geography	Human Impact on the Environment
Geography	Weather and Climate
Geography	Food and Environment
Geography	Global Environmental Change
Geography	Global Change: Past and Present
Geology	Environmental GeoHazards
Intl Relations	Global Governance
Philosophy	Ecology, Nature, and the Future
Philosophy	Environmental Aesthetics
Poli. Science	Global Justice and Social Change
Religion	Ethics of Consumption
Sociology	Globalization, Technology, and Cultural Change
Sociology	Field Research in Local Communities
University Course	Food and Society
University Course	Technical Prospectives: Life, the Universe, and Engineering
University Course	Practicing Democracy: Active Citizenship, Community Engagement and Social Change

Outside the classroom, Bucknell has additional resources that provide valuable climate-relevant educational opportunities. The Bucknell University Environmental Center (BUEC) is the primary organizer of campus-wide programming on climate change (and the environment, more generally). For instance, the BUEC organizes the annual Focus the Nation, a well-attended climate change awareness event featuring panel discussions and faculty presentations. In 2008, Focus the Nation capped off its events with a keynote

lecture by Ronald Stouffer, a senior scientist from the Geophysical Fluid Dynamics Laboratory in Princeton and a lead author on the fourth Intergovernmental Panel on Climate Change (IPCC) assessment report. Typically these educational events are open to the general public. The BUEC also hires student interns who are engaged in various research projects, often of an independent nature. Some recent projects pertaining to climate change are: creating and augmenting campus GHG inventories, contrasting the complete carbon footprint of campus office paper from purchase through disposal (recycled versus virgin pulp sources), improving energy efficiency in campus lighting methods, reducing waste and encouraging the procurement of local foods, and fostering environmental literacy at the local level.

The Bucknell Environmental Club is an important student organization supporting environmental and climate-change-related activities. For instance, 2007 the Club has partnered with Facilities to host Bucknell's participation in Recyclemania, an 8 week-long annual recycling competition among college campuses. Environmental club members have attended Power Shift, a nation-wide effort to teach youth organizational and grassroots tactics to help compel politicians in the nation's capital to enact climate legislation. Club members are also involved in establishing Bucknell's first "green" student residence and possibly proposing a dedicated student registration fee to be used for environmental purposes.

Adding Climate Emphasis to the Curriculum

The Presidents Climate Commitment encourages us to look for ways in which more climate change content might be added to the curriculum. Note that in May 2009 an on-campus faculty workshop ("Sustainability Across the Curriculum") was convened by Dina El-Mogazi to discuss ways of incorporating more sustainability concepts into Bucknell's curriculum. For more details on the outcome of the workshop and current outlook, please contact Dina El-Mogazi.

Below are some external resources on educational modules designed to promote climate change awareness and sustainability.

AASHE In April 2009 AASHE published a report entitled "**Education for Climate Neutrality** and Sustainability: Academic Guidance for ACUPCC Institutions". The document can be accessed at http://www.presidentsclimatecommitment.org/html/solutions_academics.php (click on "Education for Climate Neutrality"). The report presents curricular examples from community/technical colleges, small liberal arts schools and large research universities, focusing on consciously designed programs or organized projects/initiatives on topics such as LEED design, sustainability, and eco-literacy. Adopting some of these programs may be as simple as taking concepts that are already extant or implicit at Bucknell but creating a more formal, media-ready structure. One model discussed in this document is the Climate Education Initiative at the University of New Hampshire (UNH). This initiative focuses on the "CORE" (which stands for "Curriculum, Operations, Research and Engagement"). In this program, curricular, research and outreach efforts are wholly integrated. See http://www.unh.edu/etf/etfbasics.html.

UNESCO (which stands for United Nations Educational, Scientific and Cultural Organization) has produced an educational program called "Teaching and Learning for a Sustainable Future" (http://www.unesco.org/education/tlsf/). The program consists of 25 modules. Topics can be global in nature, including sustainable development. One important concept is "education for a sustainable future" (Module 4) which is broken down into the following sub-topics:

- To explore the holistic nature of the concepts of 'environment', 'sustainable futures' and 'education for a sustainable future';
- To clarify the emerging concept of education for a sustainable future;
- To appreciate the range of knowledge, value and skill objectives of education for a sustainable future; and
- To understand the broad scope of actions needed to reorient education for a sustainable future.

Module 7 is of interest because it relates to the role of civic participation and community/local action in bringing about sustainability. As stated on the website, "This module provides an introduction to ways in which students can develop the knowledge, skills and commitment for active and informed citizenship. This module also provides an opportunity to consider ways of teaching about citizenship for sustainable futures across the curriculum."

Sustainability and Energy Education Project "funded by the state of Michigan. Resource guides, free learning activities and curricula, and open ended questions that can be used to introduce sustainability to a variety of disciplines are available by selecting the Sustainability Education Handbook at www.urbanoptions.org."

Northwest Earth Institute – Discussion Course ("Changing CO_2URSE")

Northwest Earth Institute (NWEI) is a developer of course materials that pertain to sustainability. The text below is available at http://nwei.org/higher_education .

Discussion Course Goals:

- To explore personal values and habits as they relate to climate change.
- To understand the history and science of global warming.
- To empower individuals to take action to curb global warming.

Topics Covered:

1. Off Course: Communities around the world are experiencing the effects of global warming. This session explores personal responses to climate change and why society has been slow to respond.
2. Collision Course: To better understand the complexities of global warming, this session breaks down the history and science of global climate change and identifies our participation in this ecological crisis.
3. Changing Course: Although global warming is a daunting issue, there are accessible and significant actions we can all take. This session explores new strategies for addressing climate change and considers personal action to mitigate the effects of global warming.
4. Setting a New Course: What will it take to create a sustainable future? Explore our individual and collective power to shape an effective response to climate change, enabling future generations to meet their needs.

Low Carbon Diet (http://www.empowermentinstitute.net/lcd/)
This educational tool includes suggestions for reducing one's carbon footprint (one tag line is: 30 days to lose 5,000 pounds) and is designed to be user-friendly. Typically it is aimed at the grassroots level, meant for individuals and local communities, but many of the principles are extremely relevant for climate change education.

On a separate note, the "low-carbon diet" phrase is also used by Bon Appetit, a popular sustainability-minded dining services contractor employed by many schools (www.bonappetit.typepad.com). This company considers the various components of carbon coming from direct emissions (e.g., from beef or dairy, rice, etc.), vehicle miles traveled for delivery, and waste.

Cool Schools Students "eCO$_2$mmute" Project Manual
(http://climateprotectioncampaign.org/)
At this website you can click on a link in the left margin to access an 8-page PDF of a project that encourages alternate forms of commuting, including cycling and walking. These examples come from secondary schools, primarily, but could be applied in principle to colleges and universities (one approach: before and after surveys to see the effect of an educational campaign on commuting habits).

Environmental Literacy as a Specific Educational Goal

Good environmental stewardship rests on knowing how humans interact with the natural world, including our consumption of food, fiber, water, fossil fuels, and other valuable resources, and our specific relationship with the local environment. Promotion of environmental literacy (also known as "eco-literacy") in the Bucknell community, however, is a broadly accepted goal, according to the findings of the Environmental Assessment.

The aforementioned AASHE document "Education for Climate Neutrality" contains useful information on climate literacy, which is a refinement of the eco-literacy idea. (p.24) Andy Jorgensen and David Blockstein at the National Council for Science and the Environment (NCSE) suggest that climate literacy involves:
1. understanding the scientific basis of climate change (both the workings of the climate system, and the anthropogenic disturbances to the system);
2. understanding the environmental, economic and social consequences of rapid global climatic disruption;
3. understanding the various means by which the anthropogenic influence can be limited, the complications inherent in utilizing these means, the uncertainty about various solutions; and
4. preparing to be an active participant in climate solutions, whether as a climate solutions professional or simply as an engaged citizen.

Jorgensen and Blockstein believe that institutions of undergraduate higher education focus on #1 above (an academic understanding) but fail to address the others meaningfully. Therefore, to correct this, the other items should be prioritized as well.

Recently, a brief **environmental literacy quiz** was administered at Bucknell to assess student understanding of two types of knowledge: first, an understanding of basic concepts pertaining to major environmental policy issues, such as greenhouse gases, endangered species, and energy efficiency; second, an awareness of local ecological knowledge, such as the drinking water and energy sources, local flora and fauna, and the destination of waste (El Mogazi, Env Assmt, 2009). The quiz was administered to a group of first-year students and a group of upper-level students (mostly seniors), but the first-year students were quizzed on basic concepts only, having only a limited opportunity to observe the local environment.

> The results from the quiz revealed that students can be unaware of the workings of the environment closest to them.... [T]he upper level students scored an average of 44% on seven questions pertaining to local ecological knowledge. Yet "knowledge of place" is a prerequisite for responsible engagement in one's community, a key ingredient in attaining campus sustainability, and no less important than a grasp of broad policy issues. (El-Mogazi 2009)

How can environmental literacy, and in particular, knowledge of the local environment, be improved campus-wide?

Suggested strategies:

- Devote a portion of first-year orientation activities to learning about the local environment and necessary campus operations. As an example of progress, human resources department now regularly includes a segment on campus greening in their new employee orientation program (contact: Dina El-Mogazi). The environmental literacy survey could be expanded and administered yearly to each incoming class.

- Offer more year-round educational content on issues like recycling and energy use during the first year, perhaps organized through the Office of Housing and Residential Life.

Scholarship

Although research about climate change at the national and international levels is certainly of great importance, here, the discussion of research for the purposes of the ACUPCC will be confined mostly to Bucknellians' scholarship in the local environment.

Existing Research with a Climate Change Focus

Knowing our local environment is relevant for Bucknell's CAP because carbon accounting is taking place at the campus/community level. Some faculty members at Bucknell already capitalize on local settings as a resource for research. Professor Warren Abrahamson has conducted research, with students, on the old-growth forest community at the Snyder-Middleswarth Natural Area in Snyder County, Pennsylvania. (Such an environment could be useful for researching carbon uptake in living forest biomass.) In the Civil and Environmental Engineering (CEE) Department the work of Professors Tom DiStefano, Matt Higgins and CEE students on biological methane production under anaerobic (no-oxygen)

conditions may be relevant to the breakdown of campus food waste to product usable methane gas (an important waste minimization strategy and a source of renewable energy). This project may someday take place in the nearby town of Milton which is slated to construct an anaerobic digester.

A wide variety of student research projects have been conducted for course credit or as individual theses with significant input and assistance from faculty mentors. These have enormous practical benefit to the campus community. More information regarding student research on sustainability is available in the Environmental Assessment Report (El-Mogazi, 2009) and some of the most sustainability-relevant student research is cited in this document (especially work by Kassab and Fournier).

Promoting Research on Mitigation

To encourage more research efforts in GHG mitigation, the University should consider the following:

- Advertise that more research is needed to quantify the effects of various mitigation strategies from both a technical (feasibility) and a financial (cost/benefit) perspective.
  - Hold a meeting and introduce students, faculty and staff to important proposed mitigation strategies requiring further study. (Could coordinate through the Campus Greening Council to brainstorm potential projects.)
  - Sponsor an annual climate change mitigation research symposium for the reporting of findings. This could be a campus-wide symposium, or extended across multiple campuses with collaborators at other institutions.
- Offer small travel or research grants to allow students to visit neighboring schools to attend a workshop/conference, hear a lecture, or learn new experimental methods pertinent to climate change mitigation.
- As an incentive, award a special citation for the "best" (criteria would need to be defined!) undergraduate or graduate thesis pertaining to the topic of local climate change impacts or local mitigation of climate change.
- Contribute editorials to the campus newspaper about climate change mitigation at Bucknell, encouraging involvement in education and research activities by students and faculty.

Models for promoting research on mitigation are listed in Appendix G.

Linking Outreach and Participatory Offsets with Education/Research

This section considers the important role of so-called carbon offsets, or GHG offsets, in achieving carbon neutrality. Bucknell will strive to lower GHG emissions as much as possible by reducing or avoiding them; after that point, whatever cannot be reduced or avoided should be offset to comply fully with the ACUPCC. Using offsets simply means providing financial support to activities that take place off-campus and reduce emissions of GHGs, and otherwise would not have occurred without the financial support in question.

Buying GHG offsets has sometimes raised controversy because remote offsets can lack transparency and can be hard to verify. In contrast to paying for a remote offset, participating directly in programs or activities that generate GHG offsets helps ensure the

verifiability of the anticipated outcomes. When activities take place in the local community, and/or involve some sort of supervision, organization, coordination, or other linking relationship, these might be considered more desirable. The following programs, offices, and groups are natural candidates for consideration as participatory offsets (note that more background on each group is provided in the Assessment Report). In many cases, these experiences bring Bucknell students (and faculty and staff) outside the campus environment and introduce important cultural perspectives and influences that shape our definitions of sustainability.

Research on local ecology and ecosystems at **Bucknell's owned natural areas** (e.g., Chillisquaque Creek Natural Area, Forrest D. Brown Conference Center at Cowan, or any future acquisitions) could be valuable if they could be linked to some sort of offset, perhaps through afforestation or another land use issue.

Bucknell's Office of Service Learning oversees three programs that could be involved in climate change offsets: the Bucknell Brigade working in Nicaragua, the Katrina Recovery Team working in New Orleans, and most recently Bicycles Against Poverty in Uganda). The Brigade works with shade coffee growers and certain agricultural activities are well poised to create offsets while maintaining healthy ecosystems (e.g., enhancing CO_2 uptake by vegetation, preserving existing forest or afforesting denuded areas). In New Orleans, the efforts are to assist with the rebuilding of flooded and damaged areas ... what specific ideas for renovating in a green way? Though not geographically local, Bucknell has been involved with these types of projects for many years, building relationships and credibility; therefore, documentation should be much easier to secure compared to a typical third-party offset.

The **Environmental Residential College** is a first-year-student dormitory whose residents share environmental interests. The themed living situation facilitates out-of-classroom discussions and participation in special field trips and activities. The college would be an appropriate setting for the study of campus GHG emissions and cross-comparisons between Bucknell and other peer institutions. As students are often new to rural central Pennsylvania, this is also a good setting to address various issues of environmental literacy. It is important to note that the previous graduates of the Environmental Residential College have gone on to pioneer novel initiatives on campus, including the new Taylor House, a student residence which will be the most sustainable dormitory on campus. Therefore, the alumni of the Environmental Res College might be organized to help promote broader change at the university.

The **Solar Scholars Program** (hands-on learning experience for management of the on-campus solar arrays, including writing grant proposals, learning how to install equipment, data collection, and public outreach and demonstrations). One example of a potential outreach is to partner more directly with local homeowners to fund energy conservation improvements in local residences (e.g. Cornell University program). The Solar Scholars Program may expand soon to include wind energy.

Anaerobic digester and other **food waste** projects. A pilot student-run project was begun in the College of Engineering to study the use of an anaerobic (no-oxygen) digester to

convert campus food waste into methane, a valuable fuel.[12] Additional recent student research looked at the feasibility of scaling up the digester to be able to handle a greater proportion of campus food waste (senior design project) and to install the digester either on or near to the campus. An engineering firm was hired to help perform a project cost estimate for an on-campus digester. The estimate revealed that costs for an on-site digester were prohibitively high, suggesting that off-site coordination would be more feasible. Research on transporting Bucknell's food waste to an off-site facility is now needed.

Areas in which Bucknell could initiate offsets programs where no foundation currently exists include:

- Partner with local experts to capture **methane from dairy farms** (sources are posted on the blackboard site).
- Promote involvement by fraternities and sororities in service activities with an acknowledged sustainability component. Consider amending requirements so that some percentage of these service activities must be relevant to sustainability or the environment. An example might be installing solar panels in a local school or nursing home.
- Establish research partnerships to investigate and support cutting-edge developments in these areas:
    - **Afforestation** in PA: (work with researchers at Penn State, contact Thomas Peterson, Eric Zenner (prof of silviculture) http://soilcarboncenter.k-state.edu/conference/USDA%20Abstracts%20html/Abstract%20Peterson.htm).
    - Carbon sequestration by algae
    - Carbon sequestration by soils
    - Plant biofuels
    - Chemical means of C sequestration

In addition, outreach to the Greater Lewisburg community is recommended via these approaches:

- Meet with known regional organizations who have an interest in promoting sustainability (e.g. schools, businesses, environmental/conservation groups, Eagle Scouts, social clubs, Local Action Network, Susquehanna Economic Development Association-Council of Governments, local government, non-profits, etc.). Discuss ways to mitigate GHG emissions through education, awareness, special events, fundraising, etc.
- Establish a community program (possibly in conjunction with a local utility, local township government, or SEDA-COG) to advise homeowners on energy-saving measures and improvements. These efforts could lead to important "**local offsets**" and produce co-benefits if: (1) local jobs are created in areas such as renewable energy or insulation installation, etc.; (2) energy consumption is lowered and cost savings are reaped by local residents. As reported on the electronic weblog of "Inside Higher Ed" (http://www.insidehighered.com/blogs/getting_to_green/the_onset_of_offsets), U. Colorado (at Boulder) provides local residents, including low-income individuals,

[12] Actually, as described in Section I, food waste is currently going into Lycoming landfill, which does capture some methane, but could increase percentage captured by diverting food stream to another facility.

with funding and knowledge to reduce water and energy use, and promote recycling and alternative transportation (http://www.colorado.edu/chancellor/speeches/economicsummit051109.html) and Oberlin has a program to encourage CFL swapping in the community. As has been mentioned previously, local offsets may be more desirable than remote offsets because of increased transparency and verifiability. It would also enhance our relationship with the greater Lewisburg community.

- Use the wide-ranging social network of the general campus community to branch out and forget brand-new relationships with individuals and groups who are interested in sustainability initiatives.

Additional Resources

Academic Literature

Many articles and book chapters on environmental literacy are available, including:
Debra Rowe, 2002. Environmental literacy and sustainability as core requirements: Success stories and models. From: Teaching Sustainability at Universities, 2002, Walter Leal Filho, editor, Peter Lang, New York. This 17-pp document lists some (clearly, not all) higher education institutions that have a sustainability requirement for all undergraduates. Also discussed is the strategy of diffusing sustainability requirements throughout the curriculum. Other topics: professional development for faculty, use of minors, the role of "latent curricula" (e.g., experiences outside the classroom, culture of the campus, research, etc.) and mission statement. To answer the question of whether any of this effort makes a noticeable difference in student attitudes/awareness, Rowe (2002) argues:

> At many institutions with a general education requirement in environmental literacy, most students take only one course that addresses the environment. Is this graduation requirement enough? Wolfe's (2001) research review indicates taking as little as one course in environmental literacy does produce more environmentally responsible behavior. Benton (1993) found that MBA students who took an environmental management course were more aware of environmental issues and more willing to take actions to make a positive difference. Smith-Sebasto (1995) found a significant increase in environmentally responsible behavior among students who took one course in environmental literacy in comparison to those with no course on this topic. Rowe (1999) found that students who had an interdisciplinary course with a focus on creating a more humane and environmentally sustainable future developed an increased caring about the future of society, an increased belief that they can make a difference, and an increased willingness to participate in solving societal and environmental problems....

Knowledge is not the same as attitude. In fact, specific skills are encouraged to be taught to students to help them see themselves as "agents of change" (Rowe (2002). Continuing to cite Rowe (1999), she recommends that curricula teach the following skills to help effect change: "optimism skills to reduce cynicism and apathy (Seligman, 1998)", "efficacy skills (via stories of 'average' people making a

difference)", "envisioning future positive scenarios for society (Smith, 1987)", and "implementation skills" (Rowe, 1999).

Energy Star Resources

To aid with education of appliance users and purchasers, the EnergyStar website contains many useful links.
See: http://www.energystar.gov/index.cfm?c=challenge.challenge_toolkit for widely promoting the use of Energy Star appliances, including PDF documents and display items for printing/distribution.
http://www.energystar.gov/index.cfm?c=higher_ed.bus_highereducation is devoted to higher education needs.
Online "training sessions" are described here: (http://www.energystar.gov/index.cfm?c=business.bus_internet_presentations).
A school can "Partner" with Energy Star and be listed/credited on their website at http://www.energystar.gov/index.cfm?fuseaction=PARTNER_LIST.showPartnerResults&partner_type_id=CID&s_code=ALL.
Energy Star also gives annual awards to many businesses and schools, which is good for PR. A link can be found on the higher education website.
This link (http://www.energystar.gov/index.cfm?c=higher_ed.bus_dormroom) explains how to work with Energy Star to create a demo dorm room on campus featuring Energy Star products. The site explains, "Once it's set up, you have any easy education tool for an entire academic year (unlike an event, which is a one-time education and publicity opportunity.) The room by itself saves a moderate amount of electricity, but the project's emphasis is the 'ripple effect' of how much the school could save if every dorm room on campus used ENERGY STAR products."

Funding Available for Education

DEP's Environmental Education Grants Program
"The conservation of Commonwealth resources depends on the effectiveness of the environmental literacy of its citizens. The focus of this EE Grants Program is to support environmental education through schools, county conservation districts and other nonprofit conservation or educational organizations, including colleges and universities (DEP website)." (http://www.depweb.state.pa.us/enved/cwp/view.asp?a=3&q=473224)

EPA Environmental Education Grants: Usually $20,000 per grant to support environmental education projects that enhance the public's awareness, knowledge, and skills to help people make informed decisions that affect environmental quality. Go to: http://www.epa.gov/enviroed/grants.html . Sponsored by EPA's Environmental Education Division.

At Bucknell, the office of Financial Aid administers the **Presidential Fellow** program for Bucknell undergraduate students. Available for up to 20-25 bright and motivated students in each entering class. (Contact: Sally Koutsoliotas) Projects pertaining to Bucknell's two Tangible Actions under the ACUPCC could be suggested using this program.

NWF Campus Ecology Program provides fellowships for undergraduates to pursue research projects on sustainability in cooperation with faculty and staff. http://www.nwf.org/campusEcology/fellowships/index.cfm .

Although they do not provide grants, the organization **Second Nature** broadly promotes the issue of environmental education, in many cases focusing on climate change, at the federal level. For instance, one of their recent initiatives is asking university and college presidents to endorse a proposal to reserve a percentage of the carbon allowances auction proceeds (under a cap-and-trade system) for use in climate change education. http://www.secondnature.org/

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Section IV: Financing

Funding sources for reductions in GHG emissions will be sought from multiple sources, a variety of which are listed below:

Competitive Grants

Federal Funding

US EPA

The EPA administers a variety of grants from its different branches. The **Office of Air and Radiation** (OAR) within EPA is the branch most closely related to climate change. More information and actual RFP documents from this office (in PDF form) are available at: http://www.epa.gov/air/grants_funding.html . Some highlights from OAR are presented below.

Recovery Act Funding for the Clean Diesel Emerging Technology Program
EPA-ARRA-OAR-OTAQ-09-05 Closing Date: May 5, 2009
"[EPA announces] the availability of funding assistance through the American Recovery and Reinvestment Act of 2009 (Recovery Act), and the Energy Policy Act of 2005 (EPAct 2005). Under the Recovery Act and EPAct 2005, EPA's Clean Diesel Emerging Technologies Program is soliciting applications for projects that can be commenced quickly, reduce diesel emissions, and maximize job preservation and/or creation and economic recovery through the use, development and commercialization of emerging technologies. An emerging technology is a device or system that reduces emissions from diesel engines or diesel engine powered vehicles or equipment that has not been certified or verified by EPA or the California Air Resources Board (CARB) but for which an approvable application and test plan have been submitted for verification. Only those technologies that have been approved and placed on EPA's Emerging Technology List, found at http://www.epa.gov/otaq/diesel/prgemerglist.htm , qualify as emerging technologies...."

Activities that Advance Methane Recovery and Use as a Clean Energy Source
RFP# EPA-OAR-CCD-09-03 – Request was closed: March 5, 2009.

Sustainability for the 7th Generation Initiative (SGI)
RFA# EPA-OAR-OAQPS-09-01 - Closed: January 23, 2009

Cost-Effective Approaches To Reducing Greenhouse Gas Emissions Through Energy Efficiency, Clean Energy, And Corporate Greenhouse Gas Management
RFP # EPA-OAR-CPPD-08-04 - Closed: August 6, 2008

US DOE

The Department of Energy is another funding source. The division within DOE which is most relevant to climate change is "Energy Efficiency and Renewable Energy" which sponsors

the **Solar Energy Technologies Program**. This program operates certain grants primarily related to PV technologies and operates the "Solar America Showcase" which provides large-scale technical assistance (not materials) up to $200,000 to build a demonstration project.

State of Pennsylvania

The State of Pennsylvania, like other states, is a recipient of public money under the American Recovery and Reinvestment Act (ARRA). The latest information regarding these funds is as follows: In total an amount of roughly $455 million is available to fund Weatherization ($252,793,062), the State Energy Program (SEP; $99,684,000), and the Energy Efficiency & Conservation Block Grant Program ($102,508,400). The Block Grant Program breakdown is listed at http://www.energy.gov/media/PA-tbl.pdf and does not appear to include Union County. The State Energy Program is detailed at http://apps1.eere.energy.gov/state_energy_program/projects_all_by_state.cfm/state=PA and deals with renewables (for instance, a 2005 "community wind project" and renewable energy center was built with St. Francis University in Loretto, PA which is described at http://www.francis.edu/communitywindHOME.htm?terms=wind).

Pennsylvania's sustainability grants are administered by several different departments, including the Department of Environmental Protection (DEP), the Department of Conservation and Natural Resources (DCNR), and the Department of Community and Economic Development (DCED). Some examples are provided below.

DEP's Alternative Fuels Incentive Grant Program (AFIG)
http://www.depweb.state.pa.us/enintech/cwp/view.asp?a=1412&Q=502176&enintechNav=|
Currently (as of June 2009) closed. From the web site: "AFIG Program is helping to create new markets for biofuels in Pennsylvania". Eligible parties: "School districts, municipal authorities, political subdivisions, non profit entities, corporations, limited liability companies or partnerships incorporated or registered in the commonwealth"

DEP's Local Government Greenhouse Gas Pilot Program
http://www.depweb.state.pa.us/energy/cwp/view.asp?a=1532&q=536497

PA PUC (Public Utilities Commission) Sustainable Energy Fund
http://www.puc.state.pa.us/electric/electric_renew_sus_energy.aspx

DEP's Growing Greener Grant
http://www.depweb.state.pa.us/growinggreener/site/default.asp
This is typically for watersheds but encompasses education, renewables, C sequestration technology, LED substitution, etc.
Previously funded (2008) projects are listed at: http://www.depweb.state.pa.us/growinggreener/lib/growinggreener/GGII_08_Annual_Report.pdf

DEP's Energy Harvest
http://www.depweb.state.pa.us/energy/cwp/view.asp?a=1374&q=483024
Beginning in 2008, Energy Harvest requests are limited to no more than $500,000) is currently closed. Areas considered: renewables, e.g., Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Renewable Transportation Fuels, Fuel Cells, Anaerobic Digestion, Small Hydroelectric, Other Distributed Generation

Technologies. Typically applications open Early Spring, and application period closes Late Spring. Average Grant Amount is $200,000.

DEP's Composting Infrastructure Development Grant
http://www.depweb.state.pa.us/landrecwaste/cwp/view.asp?a=1338&q=469423
Reimburse for-profit business entities (whether established or start-up) and non-profit organizations located and operating in Pennsylvania that use organic materials limited to yard waste and food waste feedstock collected in Pennsylvania. The grant aims to increase the volume of organic materials being diverted and composted and assist businesses to increase their use of organic materials. Closed as of July 2008.

DEP's PEDA (PA Energy Development Authority) Grants
http://www.depweb.state.pa.us/enintech/cwp/view.asp?a=1415&q=504241
PEDA solicitations are varied and diverse. In general, PEDA provides grants, loan guarantees for alternative energy projects and related research referring to deployment projects, manufacturing or research involving the following types of fuels, technologies or measures: solar energy; wind; low-impact hydropower; geothermal; biologically derived methane gas, including landfill gas; biomass; fuel cells; coal-mine methane; waste coal; integrated gasification combined cycle, and; demand management measures, including recycled energy and energy recovery, energy efficiency and load management. Due Date is May 29

DCNR's Treevitalize
http://www.treevitalize.net/index.aspx
Encourages the planting of urban trees

PENNVEST, the Pennsylvania Infrastructure Investment Authority
http://www.pennvest.state.pa.us/pennvest/cwp/browse.asp?A=4
(drinking water, wastewater, stormwater projects)

DCED's Renewable Energy Program published a guide to grants for renewable energy, found at: http://www.newpa.com/find-and-apply-for-funding/funding-and-program-finder/funding-detail/index.aspx?progId=191 **.** Eligible applicants are businesses / non-profits that are development focused/ municipalities. This might be worth pursuing in partnership with a community organization, as it does not appear that institutions of higher learning would be eligible under this definition.

Available Incentives

Though some of its information duplicates what is already listed above, **DSIRE** (http://dsireusa.org) is a national electronic database based out of NC State which calls up incentives (local, state, federal) for energy projects. A search on Pennsylvania produced many results, including: local rebate programs, state grants, utility programs, and even useful information such as solar/wind permitting standards and renewable energy portfolio standards. It is a good "umbrella"-type list of available funding sources.

Official University Budget

Certain projects requiring large amounts of capital are critical enough to deserve university budget (for example, improved metering). Deciding the prioritized criteria for these projects will need to be discussed by the administration. The current economic recession may be an inopportune time to investigate capital projects.

Creation of Sustainability Revolving Loan Fund

A new Sustainability Revolving Fund could be established at Bucknell to target projects that promote sustainability. In a nutshell, a revolving fund covers the initial capital costs for a proposed energy-saving project. Over time, the realized financial savings from the project (via energy savings, for instance) can be re-deposited in the fund, allowing money to be made available for future projects. The re-invested money should allow the fund to be self-sustaining and even to grow, if an initial amount is put in to initiate the fund. This model has been used successfully at many schools. In fact, most schools that are serious about sustainability initiatives do have one.

A good example and one of the pioneers in this area was the **Harvard Green Campus Loan Fund**. The fund originally began in 2002 with $3 million, but was increased to a $12 million budget in 2006 because returns on investments were roughly double those from the general campus endowment (the revolving fund produced an average estimated 27 % return on investment, http://green.harvard.edu/loan-fund). The estimated savings is $4 million since the loan began. According to their website, the sequence of actions is as follows: the cost of the project is borne initially by the requesting party; once part or all costs have been incurred, a paid invoice is submitted to the revolving loan fund administrator; payback is given out in regular installments based on the estimated annual savings reported in the application process; a one-time nominal fee (e.g. $3) is applied to cover administrative costs. There are two types of loans: "full cost" and "incremental cost". In other words, this system does not solve the problem of covering up-front capital costs, but the payback system should function fairly straightforwardly.

Somewhat in contrast to the more officially-administered Harvard model, **Macalester College** features a more student-run revolving fund. They partnered with AASHE to produce a 20-pp guide, "Creating a Campus Sustainability Revolving Loan Fund", available on the AASHE website. The fund style described is student-driven and do-it-yourself in nature rather than administratively-led fund, and specifically targets clean energy. This could be an alternative avenue. At Macalaster College, the Student Government provided the majority of the initial start-up funds (roughly $20,000 of a total $27,000) for their successful revolving loan fund ("Clean Energy Revolving Loan Fund").

No matter what style of fund, the Oberlin Plan for Neutrality cautions that specific criteria be first agreed upon before approving projects for funding via the Revolving Fund, e.g. only approve projects which expect a better than 7 year payback, or a minimum of 12 % return on investment. This functions as a safety feature.

If desired, the Revolving Fund could be used in conjunction with a contest (held every few years) to determine the projects most worthy of receiving funding (Oberlin example: Green

EDGE fund contest). Another idea would be to highlight a special Fundraising campaign to raise awareness, held around Earth Day, for instance.

This fund could be built up from the following types of contributions:

Fees for Current Students and Donations from Faculty/Staff

Many schools now include as part of student registration fees a specific mandatory fee to fund environment and sustainability projects on campus (see examples below for a range of amounts). The types of projects can be narrowly specified or defined depending on campus preference; many of these fees at other schools are directed toward paying for renewable energy sources.

Select Campuses with Greening Fees (adapted from NWF "Higher Education in a Warming World" 2008 and AASHE website):

Connecticut College: $25 / year for renewable energy purchase (e.g. wind power)
University of North Carolina at Chapel Hill: $4 / semester for on-campus solar hot water system; geothermal system for new building.
Northland College (Wisc.): $20 / semester for on-campus Renewable Energy Fund, solar panels, Prius hybrid.
College of William and Mary: $15 / semester for facilities upgrades, student research grants, and the creation of a new green endowment.
Univ. of Illinois at Urbana-Champaign: $7 / semester. $2 is slated for Clean Energy Technology Fee and $5 is dedicated to Sustainability Fee for projects.
Univ. of California, Berkeley: $5 / semester toward sustainability projects "controlled by student" input. Based on UCSB model.
Univ. of California, Santa Barbara: $2.60 / quarter for creation of The Green Initiative Fund for green power, energy efficiency, waste reduction.
Univ. of Oregon: $0.60 / semester for renewable energy purchase.

If a hypothetical $3 / semester fee were added to Bucknell's registration fees, it would generate an estimated 3,560 x $6 = **more than $ 21,000 per year**.

If this measure appears too draconian or unpopular, a compromise might be payment of the fee by default, with an opt-out policy if students do not wish to pay the fee. As noted above, students could be given some amount of decision-making authority for which projects deserve funding if this makes the process more palatable. Sometimes student fees serve as a stepping-stone to illustrate positive returns on investments. In the case of Harvard University's Kennedy School of Government, student fees to purchase renewable energy ($5 / student / semester) were implemented for one year, after which the university decided to allocate equivalent funds from the regular operating budget instead (http://www.aashe.org/resources/mandatory_energy_fees.php).

Though less commonly practiced, and perhaps not popular in the current economic situation, faculty/staff could also be encouraged to voluntarily give some small amount back to the university to jumpstart energy-saving measures (e.g., $2 / semester?). As a payroll deduction, it would be pre-tax.

Alumni and Community Giving

Donations in this category could come from individual alumni, Class Gifts (e.g. GWU Class of 2007 gift was $38,000), families, local businesses, traditional philanthropy and fund-raising. At Cornell, a special fund for renewable energy was initially established from personal contributions from the parents of one student ("Krich Family Solar Fund"). Experience has shown that Bucknell's donors do request information about directing contributions specifically toward sustainability efforts. Simple recommendation that the option for environmental designation be formalized as a part of the Alumni Relations policy.

Fees and Penalties

Penalties can be used creatively but must stop short of alienating the campus community. Examples: Increase fees for parking, especially student parking because students generally live so close to campus (provided that alternatives such as Zipcar, carpooling, exist). Increase recycling violation fees to a level high enough to deter problems. Create fees for violation of a future energy conservation policy (yet to be designed and implemented). One suggestion regarding recycling enforcement might be to require an initial security deposit by a fraternity (which would be refunded at the end of the year) provided they are in good standing vis-à-vis their trash pickups (i.e., trash is bagged in clear bags, they don't include recyclable items in the trash, etc.).

Noted Barriers to a Revolving Fund

The establishment of a revolving loan fund necessitates a diversion of funds from the operating budget into the capital budget to fund new capital investments. Historically, these budgets have been independently assessed by separate management staff. Overcoming the status quo requires a more integrated conceptualizing of the operating and capital budgets, with great cooperation.

Despite these challenges, revolving loan funds have succeeded at many institutions. A list provided by AASHE includes: CSU Monterey Bay, Carleton, Connecticut College, Iowa State, Tufts, U. Maine, and U. Michigan (http://www.aashe.org/resources/rlfs.php , may require password.)

Borrowing (Debt Financing)

Oberlin's plan for neutrality highlights financing mechanisms that involve third-party lenders with low interest rates or tax-exempt interest, e.g. a tax-exempt bond, and certain mechanisms (called LPAs) that do not count against a school's credit rating (Oberlin 2002).

Partnering with Energy Service Companies

An option discussed in Oberlin's neutrality plan (and is mentioned in other schools as well): contracting an energy service provider who guarantees energy efficiency improvements and handles the financing. This strategy is considered less desirable financially than one which allows Bucknell to use its own capital.

Non-Traditional Sources

Greenopolis

(http://greenopolis.com/egreenu/foundations) suitable for very small projects

Resources for ACUPCC Signatories

Energy Efficiency Building Retrofit Program

The program is described at http://www.presidentsclimatecommitment.org/html/solutions_cci.htm. "The Clinton Climate Initiative and the ACUPCC are partnering to exponentially increase the number of large scale energy saving retrofit projects in campus buildings. Through this program, colleges and universities will dramatically reduce greenhouse gas emissions while lowering their energy bills, without dipping into their capital budgets or increasing monthly operating expenses."
An initial pilot project was conducted involving the participation of the following schools: Bard College, Dakota County Technical College, Los Angeles Community College District, Lee College of Baytown Texas, Mount St. Mary's University, New York University, Oberlin College, Pratt Institute, St. Lawrence University, and Syracuse University. Contacting these institutions is recommended for more details on whether the project was successful.

Site includes some frequently asked questions. For instance: "How does the financing work? Can we get access to 'below market' rates or grants?" Answer: "This is not a grant program. Schools can arrange financing through energy services companies or directly through banks. Terms are set with each school individually based on the type of financing to be done, and the school's individual credit rating. The Energy Efficiency Building Retrofit Program team will work with the banks and ESCOs to develop innovative new financial mechanisms which might ultimately result in more favorable terms or more advantageous financing options than are currently available."

Additional Contact Information:
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Director of Sustainability Financing, aputman@secondnature.org

Jonathan Magaziner, Clinton Climate Initiative Tel: (617) 774-0110 or (617) 849-1158
Program Manager and Analyst, jmagaziner@clintonfoundation.org

In the next section, we switch from discussing funding sources to explore the flip side, looking at costs borne for the purpose of reducing one's net GHG emissions via offsets.

Paying for Voluntary Offsets

Offsetting Business-As-Usual

As discussed earlier, offsets represent payments to cover mitigating actions that take place elsewhere. What is the hypothetical cost to offset all current campus GHG emissions? In other words, if emissions reductions were not prioritized and the only solution proposed were to pay for carbon emissions to be offset elsewhere, this would be a very expensive

proposition, as well as removing any potential co-benefits from the community. Based on data from the website Offset Consumer (accessed April 2009), the average price of carbon offsets from a list of seven "top providers" was **$16.84/ton** of C emissions.[13] Therefore, since Bucknell emitted roughly **40,000** tons of C in 2008, offsetting these emissions would cost the university over **$673,000**. However, if a national "cap" (limit) on carbon emissions is implemented, a point which is being discussed on Capitol Hill, a likely price for carbon might be on the order of $100/ton, raising the cost of offsets to 4.0 million. The takeaway point here is that paying a million dollars for offsets is not a cost-effective strategy nor liable to gain much traction from the University's decision-makers. Relying instead on energy conservation measures will in some cases result in net negative costs, depending on the mitigation strategy in question, and will certainly result in lower costs on average than a pure offset approach (see Section II).

Offsetting Air Travel Emissions

An area in which many schools have elected to purchase offsets is **air travel** emissions, because these emissions are difficult to eliminate and represent a sizeable portion of the overall inventory. Offsetting emissions is accomplished by paying reputable, fully documented third-party organizations. AASHE has published a guide for purchasing voluntary offsets. See http://www.presidentsclimatecommitment.org/offsetprotocol.php to access the document. One school which engages in voluntary carbon offset purchases for air travel emissions is Oberlin, which buys offsets to negate the emissions produced when (for instance) guests attend the college's commencement. Middlebury also buys offsets to cover air travel. AASHE named air travel offsets as one of its seven "tangible actions" available to signatories to the PCC. According to the AASHE website, 45 institutions currently report a commitment to using air travel offsets as a tangible action for GHG mitigation (http://acupcc.aashe.org/statistics-search.php?r=3). These institutions include Arizona State University, Northern Arizona University, Bentley College, Claremont McKenna College, Lafayette College (a peer), University of Massachusetts–Boston, Penn State-Berks, Augsburg College, Unity College, Granite State College, and many others.

Some companies which provide purchasable carbon offsets include

Carbon Neutral Company
JP Morgan Climate Care
Terra Pass ($10/ton carbon emissions)
NativeEnergy
3Degrees
Sustainable Travel International
DrivingGreen
Atmosfair
CO_2Balance

[13] Another resource which rates top offset providers is the CACP "Consumer's Guide to Retail Carbon Offset Providers" (December 2006) available at http://www.cleanair-coolplanet.org/ConsumersGuidetoCarbonOffsets.pdf. Some information may need to be updated because of the fast-changing nature of carbon prices.

Carbon Markets: Academic Institutions Trading Carbon Credits

Another emerging phenomenon is the buying and selling of carbon "allowances" or credits in the marketplace. Under this financial arrangement, a college or university has a legal contract that commits to reducing carbon emissions by a certain amount (typically 6% below baseline by 2010). If the goal is exceeded, the school can then sell the excess emissions credits in the market; if the reductions are too small, the school can purchase emissions through an offset program. As of spring 2009, the sole market-based carbon cap and trade program in North America is the Chicago Climate Exchange (CCX). Current academic participants in the CCX include: MSU, Iowa State, Tufts, U Idaho, U Oklahoma, Minnesota State, UC San Diego, Hadlow College. The CCX carbon price is currently approximately **$2 / metric ton C**. A recent market value for CCX offsets could not be determined.

Other Considerations and Caveats

It is important to consider that offsets represent a one-time action, and that they must be purchased annually to have continued effect.

Emphasis on offsets projects in the surrounding community means that potential co-benefits (e.g., more jobs, transfer of skills and knowledge) can be retained locally.

The market for carbon offsets is very new and in some ways not clearly defined. The aforementioned CACP document includes several questions to think about when deciding whether to purchase C offsets from a third-party provider, including:

- Do the providers themselves prioritize offset quality?
- How transparent is the quality of the offsets? Part of this is: Is a quantitative assessment of the offset possible (e.g., a certain number of liters of methane are captured) and are any objective standards used?
- How transparent are provider operations and the offsets selection process?
- Do providers understand the technical issues involved?
- Are specific projects involved?
- Are the projects "additional" (i.e., would not have happened otherwise) and how is this determined?
- How do providers show that projects are not sold to multiple buyers?
- Are any third-party standards used to validate?

(adapted from CACP Consumer's Guide to Retail Carbon Offset Providers, 2006)

Peer/Mentor Lessons

Middlebury College has a dedicated involvement in purchased offsets. The Vermont company Native Energy (http://www.nativeenergy.com/) has partnered with the College to oversee two projects: (1) methane generated from Vermont (family-scale) dairies and (2) wind power owned by Native American communities (see http://www.middlebury.edu/academics/ump/sap/sustainable/Carbon_Offsets.htm). As you can see in this link, the college offers the opportunity for study abroad participants to pay a voluntary fee to Native Energy to offset their emissions.

Duke University has published an extensive (100-pp) document on the feasibility of using offsets to achieve climate neutrality. Clearly a large amount of work went into this project. Duke concludes that the role for local offsets is real and valuable. The document instructs: “Duke should distinguish between offsets for compliance... and offsets for voluntary neutrality.”

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Section V: Tracking

Why?

Tracking and verifying greenhouse gas emissions on an ongoing basis, especially in response to campus growth and the success or failure of various emissions-reducing strategies, is a crucial aspect of the integrity of the CAP.

Who?

Paid Positions

Many colleges and universities have a large team responsible for sustainability tracking. These can be students, facilities staff, other staff, and faculty. Recommend creating more of these kinds of positions at Bucknell. As examples: residence halls will require more recycling and waste minimization coordinators (some schools call them "Eco Reps"); dining services may wish to employ more student helpers. Communication (e.g. public relations, dissemination of important announcements) throughout the campus will be very important, so potential positions may be required there. More official administrative backing is required to introduce/integrate ACUPCC tracking requirements into the existing administrative setting. The financing arm will also require additional organization and tracking of paperwork. Without leadership signaling that these priorities are important to campus operations, little progress or motivation is likely to be sustained. The process of securing external funding sources, whether through alumni fundraising or scientific/technical grant-writing, is also probably a job more suited to paid staff members rather than volunteers.

Volunteer Positions

If incentives are provided, volunteer positions can be very fruitful. Eco Reps positions can be on a volunteer basis. Also, there should be more campus awareness in terms of soliciting feedback and generating new ideas (for instance, green initiative contests held at some campuses). Students may be willing to participate in climate change awareness and mitigation activities for their educational and experiential, rather than monetary, benefits.

Emphasis on Continuity

Whether services are paid for or provided voluntarily, individuals should be willing to commit to a significant period of time. Implementing climate change mitigation strategies will occur gradually over time and accumulated knowledge is extremely valuable and beneficial for any trial-and-error process. The datasets involved are multi-year and consistency between iterations is crucial. Some schools require that students participate in "Eco Rep" type programs for a minimum of two years. Time commitment should be communicated to all staff along with the gravity of the whole enterprise.

What?

The ACUPCC was a voluntary pledge signed by President Mitchell in January 2008 which requires certain reporting actions. In addition, in March 2009, the Environmental Protection Agency (EPA) proposed a new Rule that would require institutions producing upwards of 25,000 metric tons of CO_2 equivalents to report their emissions. Authority for this mandatory reporting stems from the Clean Air Act and the requirements would affect approximately 13,000 facilities in the U.S. This is discussed in the following sub-section. All subsequent sub-sections generally focus on efforts related to the ACUPCC.

Mandatory Reporting (EPA)

Annual reporting is likely required beginning 2011. Contact: Jim Knight.

Documenting Data (ACUPCC)

Several things should be stored, ideally in electronic and hard-copy format:

(1) The actual Excel spreadsheet created by CACP to calculate emissions;

(2) Documentation on the origins of the RAW INPUT data, including:

- CONTACT PERSON responsible (make necessary changes to Appendix C)
- WHEN data were obtained
- Important ASSUMPTIONS and relevant UNITS (e.g., "monthly values were summed to obtain annual numbers")

(3) Documentation about the data entry / quality control:

- Differentiation between cells with no information or zero data
- What are the specific data gaps, and why were these data not available? Consider filling gaps in the future? *De minimis* criteria?
- Deviations of any kind from the current spreadsheet and the original CACP template, and why.
- A list of the graphs that are most useful and how they can be accessed.

(4) Documentation about the process of reporting data for the ACUPCC, if needed.

Monitoring and Auditing

Increased metering capacity for electricity, chilled water, and especially steam is recommended for better tracking. (Steam flow meters were recently implemented at the Weis Center and the Science Center, according to the Environmental Assessment Report).

Regular inspections/audits will be required to make sure equipment is functioning up to spec. A recurring schedule is recommended.

Progress Reports

Regularly scheduled progress reports are a recommended way to make sure that effort is distributed consistently over time and not delayed or ignored, including 1) Progress toward determining GHG emissions targets; 2) information gained regarding cost-benefit analyses for mitigation strategies; tracking of input data for the GHG spreadsheet, including calculations such as air travel. The exact guidelines, including assigning who is responsible for submitting reports, have yet to be determined.

New Centralized Reporting Requirements for Air Travel

Air travel at Bucknell falls into one of these categories:

- Fac/Staff, directly paid by the university through the Procurement Office (corporate account)
- Fac/Staff, paid personally by the traveler and reimbursed by the university
- Student, study abroad travel
- Student, athletic travel

Because air travel emissions have never been required to be recorded at Bucknell previously, it is recommend that the CGC (other administrative body) create a new requirement to report air miles traveled for each trip financed by the University.

Faculty/Staff: Department heads would need to make sure that each faculty/staff member understood the new requirement. When booking air travel through most websites, an itinerary will typically report the number of miles traveled on each flight, and this information should be recorded **by the traveler** for reporting purposes.

Some reporting options to consider:

(1) Change the existing travel expense (reimbursement) form. Add a box for air miles (next to the existing box for airfare). This information goes to the Finance Office. At the end of the year, a liaison from Finance reports to a CAP staff member an annual total of air miles traveled.

OR:

(2) At the time of travel, the traveler would fill out an additional (new, perhaps web-based?) form and submit it to a staff member who would record each individual quantity of air miles.

Example: Prof. Doe is traveling to London to conduct research. Her flight path is JFK – Dulles – Heathrow with the same pattern on the return trip. The JFK – Dulles flight is 228 miles and the Dulles – Heathrow flight is 3,677 miles. The round-trip mileage for the itinerary is 7,810 miles. She records this information (at the same time as recording the dates, cost, and other useful information for the travel) and saves it to enter later in her expense report.

For travel directly paid on the university's card a protocol is already in place whereby air miles are documented by the university's "preferred travel provider", Expedia Corporate.

At the end of the year, a staffperson from the Office of Procurement would need to inform the BUEC or CAP staff of the total air miles traveled using Bucknell's Expedia Corporate account. It remains to be determined whether any information can be pulled from Expedia Corporate regarding automobile miles traveled.

*** **BU's current travel reimbursement form (PDF) can be found online at:** http://www.bucknell.edu/Documents/FinanceOffice/Travel_Expense_Report.pdf for reference.***

Study Abroad Travel: Consult with Study Abroad Staff (see Appendix C) to coordinate new reporting requirements at the point when student travel arrangements are made.

Athletics Travel: Consult with Athletics Dept Staff (see Appendix C) to coordinate reporting requirements for all off-campus travel by air or motor vehicles at the point when travel is approved / arrangements are made.

For some perspective on the ongoing efforts at other schools in documenting air miles, please see Appendix H.

Air travel emissions calculators

Currently, air miles are being approximated from old and incomplete records, then a conversion factor of $0.25/mile is used[14] to help tally emissions. Two other resources for calculating emissions are the "Airline Carbon Emissions Calculator (http://carbon.trx.com/) by Travel Analytics, and the German website "atmosfair" (https://www.atmosfair.de/index.php?id=5&no_cache=1&L=3 for the English language version) According to its website, the Airline Carbon Emissions Calculator reports C emissions for flights for over 5,600 of the world's most popular city pairs. Note that the new protocol is not to use a blanket rate of $0.25/mile, but to use a yearly fluctuating value as described at the ATA website, http://www.airlines.org/economics/finance/PaPricesYield.htm (see Appendix G for details).

When?

GHG inventory: The ACUPCC mandates a GHG inventory be updated **every other year**.

Climate Action Plan: It is recommend that the plan be reviewed every year (perhaps hold a special meeting in late August before classes begin?); every 3-5 years revise the plan based on a campus-wide re-assessment of energy and carbon priorities, plus solicitation of campus community feedback.

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[14] Method previously endorsed by CACP

References

ACUPCC. 2007. Implementation Guide, version 1.0. Online at www.presidentsclimatecommitment.org/pdf/ACUPCC_IG_Final.pdf (accessed March 2009).

Appalachian Hardwood Center. "Case Studies on Wood Biomass Use in the Northeastern United States. Available at: http://www.dnr.state.md.us/forests/download/fpum_casestudies.pdf (accessed June 2009).

CACP. December 2006. "Consumer's Guide to Retail Carbon Offset Providers", available at http://www.cleanair-coolplanet.org/ConsumersGuidetoCarbonOffsets.pdf . Prepared by Trexler Climate and Energy Services. Accessed June 2009.

El-Mogazi, D. 2005. Fertile Ground for Campus Greening: Programming and Organizational Recommendations for the Ecological Sustainability of Bucknell University. Online at **http://www.bucknell.edu/Documents/EnvironmentalCenter/GreeningReportFinal.pdf** (accessed June 2009).

El-Mogazi, D., Editor. 2009. A Comprehensive Environmental Assessment of Bucknell University. Online at **http://www.bucknell.edu/Documents/EnvironmentalCenter/AssessmentReport final.pdf** (accessed June 2009).

EH&E (Environmental Health and Engineering). "Seven Steps to Developing a Climate Action Plan". Online presentation including audio and slides available at: http://www.eheinc.com/presentations.htm, accessed June 2009.

Fournier, E. 2008. A comprehensive assessment of Bucknell University's energy profile with performance simulations for various campus facilities. Honors undergraduate thesis conducted under the direction of Professor Molly McGuire. Available in Bertrand Library, Bucknell University.

Kassab, C. 2006. Greenhouse Gas Emissions Inventory: FY 1990 – 2004. Available at http://www.bucknell.edu/Documents/EnvironmentalCenter/Christine%20Kassab%20GHG%20final%20report.pdf (accessed June 2009).

National Wildlife Federation. Higher Education in a Warming World: The Business Case for Climate Leadership on Campus David Eagan, Terry Calhoun, et al. (2008). http://www.nwf.org/campusEcology/BusinessCase/index.cfm A 64-pp document that profiles over 100 schools and gives examples of promising initiatives ranging from topics like energy efficiency/conservations, LEED building standards, to renewable energy generation, especially viewing these issues from a cost-cutting perspective. Sections 5 (actions / solutions) and 6 (funding) are recommended.

Robertson, A. 2008. Greenhouse Gas Emission Inventory Update (1990-2008). Summary data online at http://acupcc.aashe.org/ghg-report.php?id=784 (accessed June 2009), full report available at http://www.bucknell.edu/Documents/EnvironmentalCenter/Greenhouse%20Gas%20Report%20with%20DE%20edits.pdf (accessed June 2009).

Rowe, D. (2002). Environmental Literacy and Sustainability as Core Requirements: Success Stories and Models. From Teaching Sustainability at Universities, 2002, Leal Filho, W., ed., Peter Lang, New York. Online at: http://www.ncseonline.org/efs/DebraRowe.pdf, accessed June 2009.

Appendix A: Methodology and Data Sources

CACP calculator version 6 (the latest version) was used for GHG08 and v 5 was used for GHG04. The mechanics of the calculations used in the CACP software are described at http://www.cleanair-coolplanet.org/toolkit/inv-calculator.php.

An initial GHG inventory was completed for fiscal years (FYs) 1990 through 2004 (Kassab, 2006). This inventory will hereafter be referred to as **GHG04**. For GHG04, Scope 1 data—covering on-campus stationary sources, solid waste, and losses of refrigerants—was obtained from Bucknell University Facilities. Information on the University vehicle fleet was obtained from the department of transportation and the department of finance.

Purchased power data for Scope 2 emissions was obtained from Facilities for GHG04. During the years covered by GHG04, Scope 3 transportation emissions data (for personal travel such as commuting) were not formally recorded or available and thus were omitted.

In 2008-2009, the Bucknell GHG inventory was updated with more recent data from FY 2005 through FY 2008 (Robertson 2009). The updated inventory will be referred to hereafter as GHG08. The GHG08 accomplished several important improvements: it moved existing data to the newest version of CACP, updated all emissions sources assessed in GHG04, added air travel data for student athletics and study abroad, and added commuting data. Commuting data for students and for faculty/staff were estimated from the university's demographic patterns using certain assumptions (see Robertson 2009 for more details). Some categories of emissions that continue to be omitted from GHG08 are: directly financed outsourced **air travel by faculty and staff** purchased privately, directly financed gasoline use purchased off-campus, and emissions from fertilizer use, wastewater, and paper. Categories least likely to meet the *de minimis* criterion are bolded. GHG08 was completed on May 15, 2009 and successfully submitted. The document is available publicly at http://www.bucknell.edu/Documents/EnvironmentalCenter/Greenhouse%20Gas%20Report%20with%20DE%20edits.pdf Note: *de minimis* criterion refers to the fact that gaps in the emissions inventory are permitted if they comprise less than 5% of the overall total emissions. This principle is commonly applied to most greenhouse gas inventories (not just the CACP model).

Appendix B: Campus Greening Council Members

Current as of Jan 2009

Faculty

Dina El-Mogazi, Co-Director	delmogaz@bucknell.edu
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Molly McGuire	mmcguire@bucknell.edu
Shelby Radcliffe	mmcclin@bucknell.edu
Kim Reynolds	kbr006@bucknell.edu

Appendix C: Key Personnel at Bucknell

Key personnel with responsibilities pertinent to the inventorying of emissions on campus are summarized below. (Current as of March 2009.)

Scope 1 Emissions

Category	*BU Department*	*Contact Name*	*E-mail (@bucknell.edu)*
Co-Generation	Facilities	Jim Knight	jknight
Vehicle Fleet (gas)	Facilities (on-campus) Transportation (off-campus)	Rex Cutchall Merritt Pedrick	cutchall mpedrick
Vehicle Fleet (diesel)	Facilities	Mike Patterson	mpatters
Fertilizer / Landscape	Facilities	Merritt Pedrick	mpedrick
Refrigerants / Other Chemicals	Facilities	Greg Koontz	grk015
New Construction	Facilities	Dennis Hawley	dhawley

Scope 2 Emissions

Category	*BU Department*	*Contact Name*	*E-mail (@bucknell.edu)*
Energy purchasing	Facilities	Jim Knight	jknight

Scope 3 Emissions

Category	*BU Department*	*Contact Name*	*E-mail (@bucknell.edu)*
Solid Waste	Facilities	Merritt Pedrick	mpedrick
Study Abroad Travel	Office Int'l Education	Ben Morris	bfm002
Fac/Staff Air Travel	Procurement Services	Don Krech	donald.krech
Athletics Travel	Athletics	Mike McFarland	msm026
Commuting	Facilities see Demographics below	Dennis Hawley	dhawley
Paper	TBD – discuss*		
Wastewater	TBD – discuss*		

*Note that Paper and Wastewater data were not counted in the latest (FY 2008) GHG inventory update but may wish to be summarized in the next update.

General University Statistics

Category	*BU Department*	*Contact Name*	*E-mail (@bucknell.edu)*
Student/Faculty Demographics	Registrar's Office Human Resources	Dennis Hopple Marcia Hoffman	hopple mhoffman
Operating Budget	Finance Sponsored Research	Bill George Joanne Romagni	wdgeorge j.romagni
Built Space	Facilities Planning & Instit Research	Dennis Hawley Patty Johnston	dhawley pjohnsto
Laboratory Space	Finance	Bill George	wdgeorge

Appendix D: Glossary, Abbreviations and Acronyms

Glossary of useful terms

AASHE	Association for the Advancement of Sustainability in Higher Education
ACUPCC	American College and University Presidents Climate Commitment
CACP	Clean Air Cool Planet, an organization that created (and provides technical support for) a widely used MS Excel-based GHG emissions calculator
Carnegie Classification	Refers to which degrees (e.g., B.A., Master's, Ph.D.) are offered by an institution and used by AASHE to separate schools for inter-comparative purposes
CCX	Chicago Climate Exchange, a market for the trading of carbon emissions allowances
CEE	Center for Environmental Education (K-12 focus)
CERF	Clean Energy Revolving Fund (Macalester College)
CH_4	Methane, a greenhouse gas produced in low-oxygen conditions, including fermentation (e.g. cattle gut activity) and flooded soil (e.g. rice cultivation).
CGC	Campus Greening Council (of Bucknell University)
CHP	Combined Heat and Power, a type of co-generation heating system
DEP	Department of Environmental Protection, PA State environmental agency
de minimis criterion	(from Latin) Widely applied principle that a greenhouse gas inventory can have certain omissions as long as the missing data do not exceed 5% of the total inventory emissions.
DOE	Department of Energy
EF	Emission factor, used in GHG inventory calculators to translate an activity (e.g. coal combustion) into its associated CO_2 emissions
Energy Star	A program administered by the EPA associated with energy efficiency, especially in electrical appliances
EPA	Environmental Protection Agency (Federal agency)
FTE	Full time equivalent
GHG	Greenhouse gas, an atmospheric gas that absorbs infrared radiation and re-emits it, with the net result of warming the surface.
GWP	Global warming potential, a conversion factor used to calculate CO_2 equivalencies for non-CO_2 GHGs (such as methane or nitrous oxide); relates to the persistence of the GHG in the atmosphere over time and its ability to absorb infrared radiation.
HFC	Hydrofluorocarbons, a class of GHGs with extremely high GWPs associated with refrigeration.
LED	Light emitting diode, highly energy-efficient solid-state (chemical) light source characterized by an extremely long lifetime
LEED	Leadership in Energy and Environmental Design, a set of widely used standards for environmentally-friendly building developed by the U.S. Green Building Council. Four available levels of certification are: Certified, Silver, Gold, and Platinum.
MTCE or MTeCO2	Metric Tons of Carbon Equivalents or Metric Tons of CO_2 Equivalents
MMBtu	Acronym signifying a million British thermal units; a measure of energy (equivalent to a dekatherm)
N_2O	Nitrous oxide, a greenhouse gas with primarily land use (e.g. fertilizer) and motor vehicle sources; its GWP is higher than that of methane.

PFC	Perfluorocarbons, a category of greenhouse gases associated with refrigeration and fire extinguishers
REC	Renewable energy credit or renewable energy certificate; when renewable energy is generated by a reputable source, tradable credits are created (1 per 1,000 kWh) that can be claimed upon purchase of the green power.
Scope 1, 2, 3	Under various greenhouse gas protocol, Scopes 1 through 3 refer to the source of emissions, which are, respectively: direct, indirect (purchased power), and indirect (other activities, such as transportation).
Second Nature	Organization that promotes sustainability in higher education
SEP	State Energy Program (PA) run by the US Department of Energy
SF6	Sulfur hexafluoride, a greenhouse gas
T&D Losses	Electricity lost during **T**ransmission and **D**istribution away from the plant.
T8	Fluorescent lamp which is more energy-efficient and smaller-diameter compared to the T12
T12	Fluorescent lamp which is notably less efficient than the newer T8
TBD	To be determined

Appendix E: Excerpt, Energy Report FY '08

Source: Jim Knight, Facilities, jknight@bucknell.edu.

Section III. Conservation Projects

Seven capital projects, aimed at improving energy efficiency, are currently active and summarized in the table below. Most of the projects are being funded out of the current Facilities Capital Budget. Funding for future conservation projects could potentially be provided by savings from the utilities operating budget. Each project is briefly described below.

Location	Project Description	Project Cost	Est. Ann. Savings	Comments
Science Center	Upgrade air handlers (variable flow).	$ 300,000	$ 100,000	In service
Rooke Chemistry	Upgrade DT Pumping System	$ 75,000	$ 20,000	Complete
Langone Center	Upgrade main serving area hoods	$125,000	$ 20,000	Complete
Smith Hall	Replace fan coil valves (variable flow)	$ 50,000	n/a	Complete
Various	Install Power Factor Correction	$ 35,750	$ 53,800	Complete.
Bertrand Library	Upgrade lighting ballasts, delamp.	n/a	n/a	~75% complete (est. Fall '08)

A. Science Center Variable Air Volume Upgrade – The initial phase of this project converted the existing supply and exhaust fans in both the Biology and Chemistry buildings to variable speed. This will allow total air flow to be varied to take advantage of the existing 2-state (occupied/ unoccupied) laboratory ventilation controls. Subsequent phases of the project will replace the existing room and hood controls with a variable volume system. This would allow the building to use only the minimum ventilation necessary to satisfy safety and occupancy requirements. Reducing the required air volume will substantially reduce the heating and cooling requirements of the building.

B. Chemistry Pumping System Upgrade – This project converted the hot water and chilled water system for Rooke Chemistry from constant to variable flow. This will reduce pumping costs and optimize flow and temperature, particularly during cooling season. In addition, the project includes multiple safeguards to reduce the risk of freezing coils and greatly improved monitoring and control capability. Metering has also been added to allow monitoring of building energy use.

C. Langone Center Serving Area Hood – The main exhaust hood in Bostwick Cafeteria was the incorrect design for this location. A new hood, of the correct design, has been installed at this location. A dedicated make-up air unit supplies outside air to the hood. This will reduce the amount of conditioned air exhausted from the building and improve the overall air flow balance in the cafeteria.

D. Smith Hall Valve Replacement – Smith Hall has experienced numerous air conditioning problems, particularly humidity control. Several improvements were made to improve conditions, one of which is replacing the 3-way valves on each room's fan coil unit with 2-way valves. This will allow chilled water flow to vary, saving pumping costs and optimizing chilled flow and temperature.

E. Power Factor Correction – It is the nature of electric motors that a portion of the power they consume maintains the magnetic field within the motor, known as reactive power, while the remainder is converted to mechanical work (known as true power). The ratio of true power to total power is the power factor. In most large motors the power factor is typically 80-85%. Power factor can be increased to 95-98% by adding devices at each motor to maintain the motor's magnetic field with minimal line current. Increasing the power factor decreases to total power consumed by the motor. These devices have been installed for nine (9) large motors at the central chiller plant and at Kinney Natatorium to test their effectiveness. Data is being collected and if the devices prove successful, they can be installed at other locations.

F. Bertrand Library Lighting Upgrade – During the energy audit of the library, several lighting issues were identified. The most significant of these is replacing magnetic ballasts with electronic

and replacing T-12 bulbs with T-8s. The upgrades are approximately 75% complete with the remaining work scheduled for the fall of 2008.

IV. Operations & Maintenance Practices

The Energy Team has completed a preliminary review of operating and maintenance practices in 13 areas affecting energy use at Bucknell. Current practices and procedures were compared to a checklist of energy management "best practices." This assessment combined with the audit results will identify potential capital projects, new preventative maintenance tasks, and improved operating procedures.

	Energy Management Area	Initial Scores by Area	Current Scores
1	Administration	32%	43%
2	Architectural	39%	39%
3	HVAC	23%	32%
4	Meters	71%	73%
5	Power Generation	82%	87%
6	Steam Generation	91%	94%
7	Steam Distribution	49%	52%
8	Chilled Water	83%	87%
9	Compressed Air	32%	32%
10	Water Conservation	38%	40%
11	Miscellaneous Mechanical	75%	75%
12	Electrical	65%	65%
13	Lighting	41%	41%
	TOTAL	53%	56%

Initial steps have been taken in certain areas. Many other areas will be addressed through the audit process discussed above. There remains a great deal of opportunity to improve on current practices and to reduce energy use, but the following is a brief summary of the work completed to date by the Facilities sub-teams.

Cogeneration Plant – The plant team has met three times and developed a list of 24 energy related tasks. Fifteen of the tasks are complete and another six are in progress.

Utilities Maintenance – The maintenance team completed an energy audit of Bertrand Library in the spring as part of a training program. They have also performed an audit of Taylor Hall but have not yet compiled the results.

Trades – The electricians have completed lighting upgrades from T-12 to T-8 fluorescents or from incandescent to compact fluorescent (CFL) in several locations including:

- Computer Center 204 (T-8)
- Olin Science 165, 171, & 461 (T-8)
- Chemistry 009, 010, 240 & 240A (T-8)
- Roberts Hall East (CFL & T-8)
- Vaughan Lit – Willard Smith Library (CFL)
- Public Safety (T-8)
- Biology 012 & 209 (T-8)
- Bertrand Library (T-8) approx. 75% complete
- Cooley Hall (T-8)
- Langone Center 207 (T-8)

In addition, 150 outdoor incandescent lamps have been replaced with CFL, providing over 50,000 kWh in annual energy savings.

Appendix F: "Energy Conservation Policy" Examples

Dartmouth College

(http://www.dartmouth.edu/~fom/policies/energyconservation.html)

Temperature Policy:

- Indoor temperature settings in all spaces during occupied periods will be
    - 68° F during the heating season and 78° F during the cooling season.
    - Spaces such as research facilities requiring critical temperature settings will be more tightly controlled.
- These temperatures will be set by Facilities Operations & Management (FO&M) in centrally controlled systems. Occupants who control their own thermostats are required to adhere to these settings.
- We recognize that temperatures will fluctuate within the building around these set points and every effort will be made to stay within 2° F of this range.
- Supplemental electric heaters shall only be issued by FO&M when necessary. These devices can be a fire hazard and will be allowed only in controlled circumstances with the authorization of FO&M.
- No other use of electric heaters is allowed and unauthorized heaters will be removed.

Occupant Responsibilities

- Report observations of excessive energy use and concerns to Facilities Operations & Management at 646-2485.
- Reduce space lighting by using fluorescent desk lamps instead of ceiling lights where possible; turn off all lights when leaving the room; blitz "Dartmouth Conserves" if you notice areas where there is excessive lighting.
- When not in use computers should be shut down, or set to standby or hibernate mode. External monitors should be shut down when not in use. Consider changing your system backup schedules to run during the day rather than leaving your machine on overnight, and remember to turn off printers, scanners and other peripherals when not in use.(screen savers do not reduce energy use)
- Appliances and computer peripherals: Work with Procurement Services to purchase Energy Star appliances. Turn off coffee makers, printers, and copiers when leaving at night and for the weekend.
- If you open a window to get some fresh air or because it is a nice day out, close the window when you leave the space.
- Laboratory fume heads should be shut down or closed when not in use to minimize exhaust needs.

Williams

(http://www.williams.edu/admin/facilities/service/conservation.php)

Energy Conservation Guidelines

Energy conservation continues to have a significant impact on global warming, ozone depletion and critical resource reduction. B&G is dedicated to minimizing the College's contribution to these problems. Your support of the temperature and occupancy guidelines will be a major factor in achieving that goal.

		Time Period	Temperature Range
Winter settings	Offices	7 a.m. - 5 p.m. 5 p.m. - 7 a.m. Weekend	67° - 69° 50° - 55° 50° - 55°
	Classrooms	7 a.m. - 4 p.m. 4 p.m. - 7 a.m.	65° - 67° 50° - 55°
	Dorms	Continuous	68° - 70°
Cooling settings	Comfort cooling		78° - 76°
	Equipment or animal colonies		per manufacturer or lab specifications

University of Kansas

(http://www.provost.ku.edu/policy/updates/energy_policy/)

University of Kansas Energy Policy

I. Introduction

The University of Kansas is committed to a policy of energy efficiency and energy conservation, particularly during this time of rising utility costs, tighter budgets, and new construction on campus. The goal of this policy is to create a realistic and comprehensive document that identifies energy and water conservation and efficiency as significant issues for the entire campus community. This document details steps that will be taken to address these issues and reach the energy efficiency goals of the University. This policy will be reviewed and updated periodically as public awareness, management techniques and technologies change.

II. Conservation Goals

KU has taken various measures over the years to conserve energy. In December 2002 KU signed an energy performance contract with Chevron Energy Solutions that consolidated various efforts and provided new "Standards of Comfort" that will improve both building environments and energy savings. Through the guaranteed savings of the energy performance contract, the University will reduce utility costs by about 18% over FY03 costs. By following the specific measures outlined in Section III, the campus may achieve additional savings.

III. Specific Measures

A. Buildings

Windows and doors of conditioned spaces should be kept closed. Personal computers, other office equipment, lights, window air conditioners and personal heaters should be turned off when not in use. The use of personal heaters is discouraged. Power management features of personal computers should be enabled. In winter, departments can obtain plastic film from Facilities Operations to cover single pane windows. This film may be installed by departments or by Facilities Operations as a billable service. As time and funding allow, buildings and mechanical systems will be added to the building automated control system (BACS). This will permit greater control over operating schedules and temperatures, will reduce energy consumption, and will permit implementation of demand management strategies to reduce energy costs.

B. New Construction

New construction should be designed and built to minimize energy use. The most recent version of ASHRAE Standard 90.1 - Energy Efficient Design of New Buildings Except Low Rise Residential Buildings should be set as the minimum energy efficiency guideline, since it has been shown that further reductions in energy use are economically achievable. The design process should include energy life cycle costing analyses. New construction should be added to the existing building automated control system for enhanced energy management capabilities. Alternative energy sources such as passive solar heating and heat recovery should be considered, as well as daylighting and other strategies for decreasing building energy consumption. Primary consideration should be given to connecting and/or extending central systems for heating, cooling and other mechanical systems. Year-round cooling needs should be met by utilizing the most energy efficient systems, for example plate-and-frame heat exchangers versus less efficient air-cooled systems. All new construction should include utility metering (electricity, natural gas, steam, and water).

C. Lighting

Most lighting on campus is being retrofitted or upgraded to high efficiency fluorescent lighting with electronic ballasts. Remaining areas should be upgraded as funding is available. New construction and remodels should use high efficiency lighting and minimize incandescent lighting. Interior decorative lighting should be kept at a minimum and exterior decorative lighting should be discouraged. Lighting levels recommended by the Illuminating Engineering Society Lighting Handbook should be used as guidelines to avoid over-lit spaces. Increased use of daylighting and daylighting controls should be considered because use of daylit spaces decreases energy costs and may improve productivity.

D. Heating

During the heating season, room temperatures should be maintained at 69°F when occupied. Whenever it is economically and technically feasible, night setback features of the BACS system will be utilized to allow temperatures to drop to 55°F during unoccupied periods. The only exceptions to this policy are special areas such as animal care units or research facilities that require constant or warmer temperatures. The Provost's Office will evaluate requests for exemptions on an individual basis. Facilities Operations will utilize the most energy efficient means of supplying heat for approved off-hour/holiday requests. Use of electric heaters in University buildings should be minimized. Areas that are either too hot or too cold should be reported as soon as possible to Facilities Operations at 4-4770.

E. Cooling

During the air-conditioning season, room temperatures should be maintained at 76°F when occupied. Whenever it is economically and technically feasible, night setback features of the BACS system will be utilized to allow temperatures to rise to 85°F during unoccupied periods. The only exceptions to this policy are special areas such as animal care units or research facilities that require constant or cooler temperatures. The Provost's Office will evaluate requests for exemptions on an individual basis. Window air conditioners

are used in areas that lack central cooling. Temperature settings for these units should be raised manually or the unit should be turned off when areas are not in use. Supervisors are encouraged to accommodate reasonable requests from employees who wish to wear more casual clothing because of the increased temperatures. Areas that are too cold or too hot should be reported to Facilities Operations at 4-4770.

F. Water Usage

Use of irrigation water should be minimized through rainfall monitoring. The University should also investigate collecting stormwater for non-potable uses on campus. Low water use flush valves and flow restrictors on faucets and showers should be used in restrooms. No single-pass cooling water will be used on mechanical equipment in new construction or remodels. Existing equipment that uses single-pass cooling water will be eliminated as time and funding allows. Water that does not go to the sanitary sewer system (such as lawn irrigation, cooling towers, and fountains) should be metered to obtain a sewer credit from the City. Water leaks, dripping faucets and fixtures that do not shut off should be reported to Facilities Operations at 4-4770.

G. Transportation

Use of the Lawrence Transit and KUonWheels programs and car/van pooling should be promoted. Faculty, staff and students are encouraged to walk, bike or use public transportation to get around campus. Fleet vehicles used on campus should not be left idling.

Acquisition of new University fleet vehicles should be reviewed thoroughly, and vehicles should be purchased with the highest fuel efficiency possible.

H. Purchasing

Energy efficient products should be purchased whenever possible. For examples, see the U.S. Environmental Protection Agency Energy Star products list. Recyclable and reusable products should also be purchased when feasible to reduce disposal costs.

I. Recycling

Facilities Operations is responsible for the campus recycling program. Disposal of materials in the solid waste stream represents an increasing expense for the University. Design of campus facilities should incorporate the facilities necessary to make recycling convenient for University users. When economically feasible, recycling should be expanded to include such things as green waste (for composting), construction waste, and used office waste such as computers. For more information on recycling at KU, please see the recycling web site at <http://www.ku.edu/~recycle/home> or contact Facilities Operations at 4-2855.

IV. Continued Success

There are several ongoing activities that will help ensure the success of KU’s energy policy.

A. Monitoring

No energy conservation program will be successful if progress is not monitored on a continuing basis. Most buildings on campus have metering devices installed. Meter readings can be used to track utility consumption, and the data can be used to locate problem areas as well as determine if conservation goals are being met.

B. Training

Training must be provided to ensure that both operations and service technicians have the skills and knowledge to effectively apply the technology used to achieve energy savings.

C. Maintenance

Mechanical system efficiency tends to degrade over time. Proper maintenance is required to ensure that systems operate as efficiently as possible.

D. Education

University faculty, staff and student cooperation and support of the energy policy are key to its success. An education program that provides information on utility costs, trends, and user impact on these costs will enable the campus population to understand the need for this policy, and how it can positively impact them by freeing up money from utilities for educational purposes.

VI. Suggestions

Any suggestions for ways of reducing energy consumption on campus should be addressed to the Facility Operations Energy Manager at 864-5695.

Note that http://www.aashe.org/resources/energy_conservation_policies.php lists policies from several other institutions.

Appendix G: Models for Integrating Sustainability and Climate Change into Education and Research

Suggested models for First-Year Orientation/First Year Education

Smith College: Smith introduced a pre-orientation program targeting sustainability in 2008, intended for about 30 students (title: "Sustainability and Ecological Literacy"), thus targeting just a small population.

> "One of the most important questions facing humanity is how can we live in an environmentally sustainable fashion," said Professor L. David Smith, the director of Smith's Environmental Science and Policy Program. "According to one calculation, the average U.S. citizen has an ecological footprint that is five times greater than what the planet can support. We can do better than that and it starts with education."
>
> Prof. Smith plans to explore such topics as where the water and food at Smith comes from; where waste goes; what system powers campus and how students can save kilowatts and BTUs.
>
> There are also such basics to address as how to recycle here, how to travel around the area without a car, and what kinds of environmental courses and student organizations are options at Smith.
>
> It won't all be classroom work; Prof. Smith will ***introduce students to the key people on campus who work to make operations more sustainable*** and the curricula more environmentally focused. Short ***field trips to locations such as the city's water sources, wastewater treatment facility and Smith's power plant***, will give the students an ecological ***sense of place***[15]. (emphasis added)

Comments: This model could be easily introduced at Bucknell as part of the Environmental Residential College. Visit Lycoming landfill, on-campus cogen plant, meet with members of Facilities department, local public water supply, wastewater treatment plant, look at the off-site composting area or pilot digester project.

UPenn: Even closer to home, at University of Pennsylvania, a week-long student training program called "PennGreen" has been designed in a pilot form. The program is designed for upperclassmen, teaching them facts and concepts that they can then pass along to incoming first-year students throughout their initial academic year. The program debuted in August 2008 and the first class of first-years will receive their educational sessions beginning in August 2009. The orientation itself sounds almost like summer camp:

> Over the week, they will visit and dine at several local farms, tour Penn's Morris Arboretum, hike the Wissahickon Creek, rock climb, go camping, participate in the

[15] June 25, 2008 press release (http://www.smith.edu/newsoffice/releases/orientation_828.html)

Philly Orchard Project and tour the Blue Mountain Recycling plant, Philadelphia Waterworks and Penn's chiller plant. On campus, they will have a cooking session with an area chef, focusing on locally produced products, and breakfast with senior administrators. The program will conclude with a canoe trip and ecological tour of the Schuylkill River. (see http://www.upenn.edu/pennnews/article.php?id=1431, also http://www.vpul.upenn.edu/osl/preprog/pgdesc.html)

Comments: The idea of involving upperclassmen is an interesting angle. This program seems to be more involved, perhaps funding may not be available. The impetus for the program is student-driven. According to a publicly available document, the UPenn Undergraduate Assembly requested and was granted approximately $4,200 to fund the program (http://pennua.org/?page_id=22). Sponsors for the program currently include: Office of The Provost, Facilities and Real Estate Services, Fox Leadership, and the Environmental Studies Department.

Green Mountain College (in Poultney, VT): GMC discusses shrinking one's carbon footprint and environmental impacts during its first-year orientation (one activity is billed as: "read the meters from rooms that house students overnight to show how much electricity is used in an average dorm room" (http://www.rutlandherald.com/apps/pbcs.dll/article?AID=/20080824/ENVIRONMENT/808240330/1048/ENVIRONMENT).

Lafayette College: One of Bucknell's general peers, Lafayette, in nearby Easton, PA began an environmentally-themed orientation program in 2008 called "Live Green Lafayette". Although it is not as in-depth as the programs described above (e.g., no specific discussion of campus operations), there is discussion of environmental impacts and personal commitments to sustainability. This may be a spin-off program from the Live Green program at Colorado State.

Harvard Green Labs: At any institution of higher education, one of the biggest challenges to reducing carbon emissions is the immense amount of resources (energy, chemicals, water) consumed by research laboratories. Harvard's program, apparently based on the example of UC Santa Barbara, calls on students to analyze comprehensively the resource efficiency of labs to determine where progress can be made. Harvard's strategy is to employ students in this role. "Five students with strong backgrounds in laboratory science are now working in paid positions as Lab Sustainability Representatives, gathering lab-specific best practices and spreading the word about how to save energy, resources, and money in similar labs. So far, seven labs have already begun lab sustainability assessments, with several others on a wait list for upcoming assessments." See http://green.harvard.edu/node/252. However, at Bucknell, the model could be adapted for application as student research projects: either independent study or honors thesis work.

Models for Research and Experiential Learning (PA Institutions)

Because Pennsylvania is home to many institutions of higher learning, students at Bucknell may wish to capitalize on ongoing research efforts taking place in the state.

Penn State. The Institute of Energy and the Environment (PSIEE) coordinates most of Penn State's climate- and sustainability-related research. The PSIEE is directed by Tom Richard and the institute's research programs operate on a roughly $120 million annual budget. In May 2009 PSIEE released a report (see http://www.environment.psu.edu/news/2009_news/may_2009/sustainabilityBOT.asp) on Penn State's progress toward sustainability.

Can we grow plant crops using solar energy and harvest these for combustion to create energy (this is considered carbon neutral if no additional fossil fuel inputs are used)? Tom Richard at Penn State is working on these issues of bioenergy.

Also at Penn State much "meta-research" is taking place at the broader level, with interest in improving sustainability overall. The Green Destiny Council is described here: http://www.bio.psu.edu/Greendestiny/ and more information is available at: http://www.bio.psu.edu/Greendestiny/publications.shtml. Penn State also has a "Center for Sustainability" directed by David Riley.

Prof. Donald Brown at Penn State is director of the Pennsylvania Environmental Research Consortium (http://www.paconsortium.state.pa.us/default.htm). His area of expertise is the ethical dimensions of climate change, especially internationally. PERC is a large collaborative group dealing with sustainability science and policy issues at the state level from a research perspective. Major committees are: greening of colleges and universities, climate change/energy, human health/environment, and "sustainable Pennsylvania". Profs. Alf Siewers, Peter Wilshusen, and Dina El-Mogazi are Bucknell representatives to this group, according to this website.

Prof. Richard Alley, professor of Geosciences is a Penn State faculty member renowned for his expertise on the science of climate change.

Penn State conducts several interesting outreach activities (http://www.environment.psu.edu/news/2009_news/may_2009/sustainabilityBOT.asp) describing energy efficiency/management counseling for local businesses, local governments, and local residents. The diverse methods described include training modules, videos, conferences and visits.

Carnegie Mellon. Some climate change research highlights include:
Civil and Environmental Engineering faculty researching the effect of food miles traveled on carbon footprints (Christopher L. Weber and H. Scott Matthews);
Vulnerable ecosystem / "tipping point" research;
Research on climate change prediction and decision making (a major multi-million-dollar grant funded by NSF covering areas like insurance, electricity utility management, and natural resource management, Center Director Granger Morgan, see http://cdmc.epp.cmu.edu/);
Impact of climate change on air quality (PI: Peter Adams), and
General participation in the Global Change Integrated Assessment Program.

Allegheny College. These initiatives and collaborative projects are mentioned on the college's sustainability website (http://www.allegheny.edu/green/): Green roof project on the Vukovich Center for Communication Arts; "Creek Connections" natural science

education outreach program with local public schools; faculty/student working partnership with local manufacturer Acutec Precision Machining to conduct a wind feasibility study, including aspects of GIS, turbine types, and economic feasibility; local foods "FarmSource" program; CEED, the Center for Economic and Environmental Development. For more details, try contacting Kelly Boulton, the campus sustainability coordinator at kelly.boulton@allegheny.edu .

Dickinson College. The college's Center for Environmental and Sustainability Education is a focal point for environmental and climate change research (see http://www.dickinson.edu/departments/cese/) funded by a grant from the Mellon Foundation as well as matching funds from the university. Students are actively sought for paid projects of varying type and skill level. Dickinson appears to provide strong support to sustainability projects through various in-house grants such as "environmental education fund" grants which are available both to students and to faculty. The "Living Laboratory" project is an interdisciplinary program to involve students in interesting environmental projects and promote experiential learning. Some of these have connections to shrinking the size of one's carbon footprint; in particular there is a Center for Sustainable Living which is a low-carbon, low-resource student residence hall. In terms of additional faculty interest, Professor Neil Leary teaches a course on "Climate Change: Causes, Consequences, and Responses". Students from this class recently composed an educational website on climate change vulnerability and adaptation found here: http://sites.google.com/site/vulnerabilityadaptation/ .

Appendix H. Air Miles Documentation: Excerpts from Green Schools E-mail Forum

The question I asked the forum was whether institutions had had any difficulties with reporting of air miles traveled. Specifically I asked:

(1) Who is in charge of recording the miles? Do individuals fill out this information on a travel expense report, for instance? How does it then get centralized?
(2) Assuming that changes were made to the campus protocol for reporting travel, how did you communicate these changes? Training/guidance of travelers, staff? Were any of the reforms unpopular and how were conflicts resolved?
(3) Any other roadblocks, suggestions, or lessons learned? Feel free to share anything you found interesting.

Overall, the consensus from most respondents was that the existing travel reporting protocol at their institution was too inadequate / cumbersome / decentralized to allow personnel to collect the required data in a sensible way. In some cases, efforts were underway to make changes to the protocol.

Responses below were received via e-mail during May 2009 and are minimally edited only for the sake of clarity and organization.

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Berea College
Tammy Clemons, Tammy_Clemons@berea.edu

I've pasted below some excerpts about our process from a follow-up report to our GHG inventory that the Energy Manager and I submitted to our administration. We're lucky that we did have substantial data available, though part of the collection was extraordinarily tedious. We made several recommendations about modifying the current system to increase efficiency of data collection and retrieval for various purposes and plan to meet with the administration soon to discuss these opportunities for improvement. I hope it's helpful!

Directly Outsourced Travel

The Sustainability Coordinator contacted the Associate Controller in the Financial Affairs Department and the Education Abroad Advisor from the Center for International Education (CIE) to request documentation of employee work-related travel as well as air miles resulting from study abroad travel by faculty and students.

The leadership team met with the Associate Controller to discuss the formatting and filing system for employee travel reports. They learned that while all travel reports are scanned, they are saved by employee name rather than by fiscal year. Furthermore, these documents were not scanned with activation of optical character recognition (OCR) setting, which automatically "reads" and converts scanned text for future search access. Therefore, the electronic files could not be searched and filtered for key terms pertaining to date or relevant travel information such as mode of transportation or personal reimbursement miles.

Hard copies of travel expense reports for FY '07-08 served as the primary documentation for employee air and ground travel. The Sustainability Coordinator and student Assistant Program Coordinator went through each month's stack of travel reports and used the following categories of information to document and sort the information by hand: destination, method (air or car), car type (rental car, reimbursed mileage, or Development vehicle), round-trip distance, and number of passengers (for air travel). Travel reports that obviously applied to study abroad travel were omitted since these were accounted for elsewhere (see below). All personal reimbursement miles and Development car miles were documented in the travel reports, and some rental car miles were documented. **The Assistant Program Coordinator calculated round-trip distance for all additional destinations by using zip codes for car miles and by using airport codes for air miles.[1] This information was then entered into an Excel workbook with each month's total travel-related information with additional spreadsheets dividing and summarizing total air miles, total rental car miles, total Development miles,[2] and total personal reimbursement miles. The total round-trip miles for each trip were then multiplied by the number of travelers (for air miles only), and the miles for all trips were totaled for each separate category of method/type of transportation.**

The leadership team also met with the Education Abroad Advisor to discuss the information needed to calculate additional air miles from study abroad. He provided an Excel spreadsheet listing all travel abroad countries for 2007-08 as well as total number of faculty and students who travelled to each destination. The student Assistant Program Coordinator then calculated round-trip distance by using international airport codes. The spreadsheet was expanded to insert round-trip mileage for each destination, and then the total distance for each was multiplied by the total number of travelers. The air miles for all study abroad countries were totaled, and this number was added to the total air miles documented on employee travel reports.

Mode of Transportation	Unit Of Measure	BC FY 2007-08
Faculty/Staff Work-Related Air Travel	Miles	561,066
Faculty/Student Study Abroad Air Travel	Miles	2,581,261
Rental Cars	Miles	26,420
Personal Mileage Reimbursement	Miles	175,438
Non-Motor Pool Campus Vehicles	Miles	63,572

Footnotes:

[1] The Google Maps (http://maps.google.com) "Get Directions" feature was used to establish baseline round-trip miles for each employee destination logged for reimbursement. The World Airport Codes website (http://www.world-airport-codes.com/) was used to acquire airport codes for international destinations, which were then entered into WebFlyer website (http://www.world-airport-codes.com/) to calculate baseline round-trip mileage for each location.

[2] Development car mileage technically qualifies as a Scope 2 Mobile Combustion since these vehicles are owned by the College. However, the measurement unit for College-owned fleet vehicles is total gallons by fuel type as opposed to total miles, which is the unit for outsourced travel. Also, Development fleet mileage is already reported on the supplemental travel report that accompanies the Berea College travel expense report. Therefore, this information was included in Scope 3 Directly Outsourced Travel.

The Berea College Travel Expense Reimbursement Policy is included in the Berea College Employee Handbook (http://www.berea.edu/peopleservices/employeehandbook/employmentpolicies/terp.asp) as well as on the Finance website (http://www.berea.edu/vpf/accounting/documents/TravelPolicy.pdf).

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UCAR
Kimberly Kosmenko, LEED AP
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Here at the University Corporation for Atmospheric Research, we developed methodology for estimating our air travel emissions based on survey of our physical records. We are a scientific research institute that provides facilities and collaboration for our 70+ university partners engaged in the study of atmospheric sciences.
Our travel department records the total dollars spent on airfare and the destination city of the traveler (but not the origin city) in their database. They maintain paper records of all travel authorizations, on which the following useful information is recorded: origin city, destination city, length/dates of trip, copy of airline ticket receipt (which often, but not always, indicates any stopover cities). All travelers traveling with UCAR funds must complete a travel authorization, whether they are employed by our organization or are collaborators for whom we are funding travel. Under advisement of one of our statisticians, an intern and **I reviewed a sampling of our paper travel authorizations and created a spreadsheet listing the travel path and distance traveled by air (distance based on numbers from Air Routing International.) We calculated the % travel authorizations that contained air travel, then used our sampling to extrapolate the total air travel for the organization** based on the total number of travel authorizations for the year.

Close to half our air travel is booked through a local travel agency that is excellent about providing data on our travel. By calculating the % air travel booked through our travel agency based on our sampling of travel authorization forms, we were able to see that our overall extrapolation of miles traveled was probably a bit low, but within the right ballpark.

I don't anticipate a change in the travel record-keeping in the near future, but **I do feel our sampling methodology (while time consuming) gives us a good estimate of our travel. We haven't touched business travel by train, bus, taxi, etc because we can't even begin to sort out the records on those modes of travel and I don't see the potential results being valuable enough to make it worth going through the time-consuming exercise**.

=====

Syracuse University
Rick Martin, <rjmart01@syr.edu>

This was a real problem area at Syracuse. Travel purchasing was totally decentralized a number of years ago, and isn't likely to be recentralized in the forseeable future. So...

Some of our air travel was easily documented (primarily, travel by employees who had university-issued "travel & entertainment" cards). Other was technically documented, but not centrally or in a consistent and accessible format (including much travel charged to personal credit cards and then reimbursed by the school). Some we could project based on other sorts of information (like study abroad enrollments by semester and location), and some we knew we'd never get.

We're in the process of designing procedures and software which we hope will allow us to capture a bigger portion of the air travel data, but we'll probably never get the whole story. Still, I think it's

important that air travel be reported under the PCC, because it's an area where schools have some control (if only indirectly) and may have significant opportunity to reduce emissions.

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AASHE

[In his response, AASHE representative Niles Barnes, niles@aashe.org, provided two URLs.]

http://www.aashe.org/blog/guidance-scope-3-emissions-pt-2-air-travel

[The above URL contains the following information:]

The business office is likely to maintain records on travel reimbursements, probably in the form of total expenditures on air travel. You can then use statistics on the average price per passenger air mile from the Air Transport Association of America to convert the total air travel expenditures into passenger air miles.[16] Unfortunately, these figures exclude taxes, and other ATA data indicate that taxes can comprise about anywhere from 10 to 50 percent of the total ticket price. We recommend adjusting the cost per passenger mile up by 20 percent to take taxes into account.

If the available figures from your business office don't differentiate between air travel and other travel expenditures (like lodging, car rentals, food, etc), you can use a random sample of travel reimbursement requests to estimate the percentage of total travel expenditures that is used for air travel.

To ensure that you haven't left out any of the institution's air travel, you'll also want to check if data supplied by the business office includes air travel for study abroad programs and campus athletics. If not, the study abroad and athletics departments should each be able to provide you with a list of destinations and the number of travelers on each trip. You then calculate total passenger air miles for each trip by using one of the many online tools that show the round trip distance between the airport closest to your campus and each destination.

Here's an example to illustrate how this works in practice:

In 2006, Example College spent $1,000,000 on total travel expenses, not including travel paid for by the study abroad and athletics programs. A random sample of travel reimbursement requests indicated that 80 percent of travel expenses went towards air travel. ATA statistics show that the price per passenger air mile in 2006 was 13 cents. Analysis of data provided by the study abroad and athletic programs show that the study abroad program was responsible for 250,000 passenger air miles while the athletic program was responsible for another 500,000. Total passenger air miles would then be calculated as follows: 250,000 + 500,000 + ($1,000,000 * .8) / (.13 * 1.2) = ~5,750,000 passenger air miles

This method isn't precise, but it does provide a good ball-park estimate of total passenger air miles that should be sufficient for purposes of a GHG inventory.

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[16] [Footnote is quoted from the posting]: AASHE previously recommended that campuses use a figure of 25 cents per passenger mile to convert total air travel expenditures into passenger air miles. We now believe the ATA's statistics referenced above to be more appropriate for this purpose, especially since they are updated annually. Special thanks to Carol Dollard and Patrice Stafford at Colorado State University for bringing this data source to our attention.

Adjusting for Radiative Forcing

Once you have an estimate of the total passenger air miles paid for or through your institution, you'll need to decide whether you want to estimate only the carbon emissions from air travel or whether you want to estimate the total contribution to climate change due to your institution's air travel. According to the Intergovernmental Panel on Climate Change (IPCC) and others, air travel's actual contribution to climate change is potentially several times higher than would be captured by looking at carbon emissions alone. This is because other effects of air travel, including upper atmosphere emissions of NOx and the formation of contrails, also contribute to climate change.

In an attempt to take the full impact of air travel into account, many institutions multiply their carbon emissions from air travel by what is known as a radiative forcing factor. The Clean Air-Cool Planet Campus Carbon Calculator, for example, incorporates a radiative forcing factor of 2.8, which is derived from IPCC's best estimates of the ratio of total radiative forcing from air travel to that from CO_2 emissions alone. It may well be an underestimate since it doesn't incorporate air travel's impact on cirrus clouds, which is not well understood but believed to result in additional radiative forcing.

http://www.aashe.org/wiki/climate-planning-guide/carbon-footprint-and-emissions-trajectory.php#DataCollectionandCalculationMethodforCommutingandAirTravel

[The above URL contains the following information:]

4.1.1 Data Collection and Calculation Method for Commuting and Air Travel

More so than for most other categories of GHG emissions, those associated with commuting and air travel tend to be based on assumptions. To make these assumptions, some raw data is needed but it tends to be indirect in nature. For guidance on data collection and calculations for these two categories of emissions, see "Guidance on Scope 3 Emissions: Commuting" by Niles Barnes and "Guidance on Scope 3 Emissions: Air Travel" by Julian Dautremont-Smith.

For commuting, your goal is to estimate the number of gallons of gasoline that is consumed by this activity. To do that you will need to estimate total miles driven and make an assumption about average fuel economy. A fair number to use for the latter is the U.S. average fuel economy for all cars and light trucks, estimated by the U.S. Environmental Protection Agency to be "an uninspiring 20.8 mpg". Coming up with total miles driven is a bit harder. Some schools have required that all students, faculty and staff requesting a parking permit fill out a questionnaire to provide this data, i.e. round trip commute mileage, number of trips per week, etc. Other schools have used existing parking hang tag databases which contain home or campus address information and extrapolated from that – subtracting out the savings associated with those with parking passes who occasionally carpool, bike, take public transit or walk. Depending on your methodology for calculating the carbon footprint of commuting, it may or may not capture the emissions reductions that occur as a result of transportation strategies you implement to reduce driving and fuel use.

For air travel, your data collection goal is total passenger air miles paid for by or through your institution. Getting to this number may be difficult, depending on how travel information is collected and archived by your school. In addition to carbon dioxide emissions associated with burning jet fuel, the climate impact of air travel is a function of upper atmosphere emissions of nitrogen oxides and other factors. The Clean Air-Cool Planet Campus Carbon Calculator incorporates a radiative forcing factor of 2.8 to account for this additional impact.

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We've communicated our concerns to our travel department and are hopeful that a more rigorous tracking system can be implemented in the future. Based upon feedback from the department they felt that obtaining more specific data would be beneficial to them as well and have therefore made hiring an IT staff member (who would focus on improving the data recording system) a top priority. We were persistent but patient with our travel services folks and it, hopefully, will pay off in the future. In the meantime, we've been able to backtrack data from the travel agencies that we use – WorldTek, Sanditz, and Orbitz. Two out of three of the travel agencies were fantastic about getting back to us with, and even included emissions breakdowns related to the travel data....
[....]
[O]ur initial recommendation at UConn will likely be to (1) focus on improving our data collection system, (2) serve as an advocate in the region for improved mass transit options, and (3) expand education regarding the impacts of air travel and alternative options. As a state institution, the out-of-state travel ban that was implemented by Connecticut, will likely result in a decrease in air travel related emissions for 2008. Assuming that the ban will at some point be removed, we are anticipating an associated future spike in air travel emissions despite our best outreach efforts.