Growing Green

Becoming A Carbon Neutral Campus

Duke University Climate Action Plan
October 2009

Duke Climate Action Plan
October 15, 2009

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October 15, 2009

Executive Summary

Introduction and Importance of Duke's Climate Commitment

Duke President Richard H. Brodhead signed the American College & University Presidents Climate Commitment (ACUPCC) in June 2007, committing the university to develop an institutional plan to achieve climate neutrality. This initiative is a part of Duke's deep-rooted culture of public engagement and the belief that the University has the duty to share the knowledge of faculty and students to address pressing global issues. To guide the development and implementation of the campus Climate Action Plan (CAP), President Brodhead asked Executive Vice President Tallman Trask and Bill Chameides, Dean of the Nicholas School of the Environment, to co-chair a Campus Sustainability Committee (CSC) comprised of representative faculty, students, and operational staff including sustainability director Tavey Capps, who manages the work of the committee.

The CSC was charged with the task of developing a Climate Action Plan that identifies a target date for neutrality, interim milestones, strategies and mitigation projects that would allow Duke to reach its target, and mechanisms for tracking progress on goals and actions. While the University intends to take aggressive action toward on-campus carbon reduction, it accepts the reality that given its location in the southeast, carbon offsets will be a part of the overall climate neutrality plan. The CAP also identifies strategies to ensure students graduate with an understanding of sustainability and that the entire campus community is engaged in this ambitious institutional effort.

It should be noted, that the institutional motivation for such efforts at Duke goes well beyond crafting this Climate Action Plan. The University recognizes that many environmental challenges are at a critical juncture where knowledge and action are needed imminently, and the awareness of this among the general public and policy makers is at an all time high. Duke has unique strengths to address these needs, including academic, facility, and personnel resources.

Duke Greenhouse Gas Footprint

Consistent with national trends, Duke's greenhouse gas (GHG) emissions have been increasing over the past 17 years. In FY 2007[1], Duke's total GHG footprint, including the Duke University Health System, was 433,961 metric tons of CO2e. Operationally, the main sources of Duke's GHG emissions were electrical usage (53%), the campus steam plant (24%), and transportation (23%). Less than 1% comes from fertilizer usage, solid waste and refrigerants. Duke University has also modeled the future institutional emissions if the current trajectory were left unchecked. Assuming there are no reduction measures taken at Duke and no external factors such as carbon legislation or increased fuel economy standards are implemented, Duke's emissions would grow to 668,608 metric tons of CO2e by 2050. Campus steam production and purchased electricity would combine for 79 percent of the emission footprint. The other 21 percent would come from transportation activities. This "business-as-usual" scenario, even taking into consideration the recent economic downturn and reduced campus construction,

[1] FY 2007 for Duke University represents July 1, 2006 – June 30, 2007.

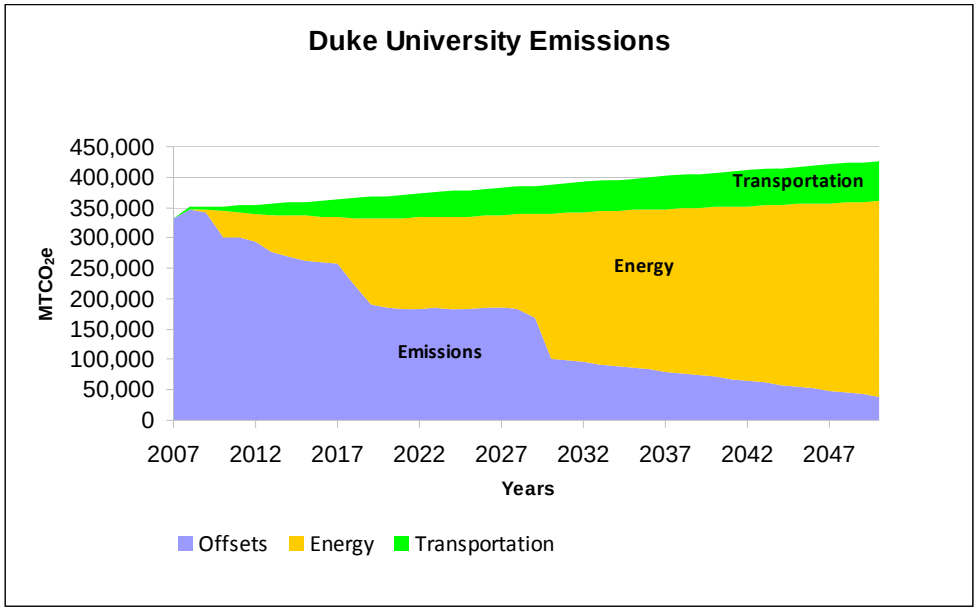
represents an increase of 54 percent in Duke's emissions. When put into these terms, the need for proactive GHG reduction strategies is even more apparent at Duke.

To facilitate the CAP planning process, working groups from the Campus Sustainability Committee were formed around five specific focus areas – transportation, energy, offsets, education and communication. Please refer to the Summary Recommendations for a more detailed description of Duke's recommended CAP actions and strategies.

Target for Neutrality

As Duke has explored its GHG footprint, potential climate neutrality target dates and the required investment related to carbon offsets, it also began the task of identifying the emissions that stem from University[2] operations separately from the Duke University Health System. This segregation of emissions is due to the unique operational requirements and future growth patterns of the two entities. The total GHG footprint for the University emissions in 2007 was 332,972 MTCO2e. Future emission targets will be measured from this 2007 baseline.

The Climate Action plan identifies targets for the University separately from the larger Duke institution, which includes the hospital, outpatient clinics and support facilities for the health system in Durham. As a result, Duke's plan will be more comparable to the plans of the majority of other higher education institutions that do not include their healthcare facilities. While Duke's target date for carbon neutrality will only apply to the University, it should be noted that the operational changes and future campus emission reduction measures will also result in a lower GHG footprint for the Health System facilities which are located contiguously with West Campus and share common systems and services.



[2] Duke University is located on approximately 8,000 acres in Durham, North Carolina and at the Marine Lab located on Pivers Island in Beaufort, North Carolina. Duke includes undergraduate, graduate and professional schools of business, divinity, engineering, environment, law, medicine, nursing [and as of July 1 2009 public policy].

The graph above shows the potential reduction in emissions as the result of implementing recommended transportation and energy reduction measures within the University compared to a business-as-usual scenario of 426,466 MTCO2e in 2050. Reduction measures such as moving completely off coal in the campus steam plant, key energy conservation initiatives, installing solar PV on campus buildings, providing direct financial incentives for alternative transportation and improving regional transportation options are several of the actions Duke would take to reduce the campus carbon footprint to the lowest levels possible. The remaining emissions, in blue, represent what Duke would have to offset to become carbon neutral at a particular year.

Duke has thought carefully about selecting a climate neutrality target. There is a need to balance short- and long-term financial implications with the desire for near-term action that could have a more significant affect on global climate change. The university has made the first significant capital investment in GHG emission reductions to bring the East Campus Thermal Plant on line as a natural gas plant. Future capital investments, operational costs and savings, legislation, and technological advances over the next 15 or more years could influence the pace at which the goal will be achieved. The University has also considered years that have a particular significance beyond GHG emissions to further engage the campus community. As such, the year 2024, the 100th anniversary of the James B. Duke's Indenture of Trust, has emerged as a date with special significance to the campus that also fits into the other evaluation criteria.

If Duke accomplishes this reduction scenario by 2024, the campus GHG footprint will be cut nearly in half from the 2007 baseline. This would leave 182,988 MTCO2e to offset in 2024 to become climate neutral. If the Duke Carbon Offsets Initiative moves forward as expected, the University will have many options in the future to meet this need for high quality, local offsets. It should also be noted that there is a financial benefit to starting to purchase offsets or invest in offset projects in the near term when the price is lower.

Milestones

As Duke works towards a goal of 2024 for climate neutrality and significant on-campus GHG reductions, efforts will also be focused on interim GHG reduction milestones. These include the following reduction percentages every five years starting in 2010 calculated from a 2007 baseline:

- 2010 – 10%
- 2015 – 21%
- 2020 – 45%
- 2025 – 45%
- 2030 – 70%
- 2035 – 74%
- 2040 – 79%
- 2045 – 83%
- 2050 – 88%

While expected campus growth assumptions, economic conditions, and Duke Energy's potential emissions reduction could have a significant impact on Duke's ability to meet these reduction goals, it is still important to have short-term milestones to measure and periodically assess

progress given changing circumstances over time. More detailed milestones for energy and transportation as well as measures for tracking progress are included in the CAP document.

Conclusion

During the last several years, Duke's considerable efforts to affect a culture that recognizes the broader impacts of the institution and values sustainable solutions has helped to distinguish the University's deep commitment to sustainability. However, a more comprehensive and coordinated effort is needed for Duke to truly become sustainable and meet its carbon neutrality goals. Numerous campus groups and individuals have already contributed their expertise and passion to bring this university to the point it is now --- celebrating current sustainability efforts and developing the path to forge into the future.

Summary Recommendations

To facilitate the CAP planning process, working groups were formed around five specific focus areas – transportation, energy, offsets, education and communication (See Appendix A for a full list of CSC members). After extensive analysis and scenario planning, each subcommittee developed key recommendations. The focus of Duke's plan revolves around aggressive on-campus reductions in energy and transportation GHG emissions. The University hopes to encourage innovation and regional efforts to reduce emissions by providing successful examples of technologies such as solar PV, solar thermal, biomass and biogas steam production, and hybrid fleet vehicles. Duke's efforts to tackle the harder emissions to control such as employee air travel could also spur other universities and businesses to adopt similar initiatives. The following recommendations that make up Duke's CAP not only set the path for a climate neutral campus; they will also hopefully serve as an example to many others of how an institution can develop the path to achieving this ambitious goal.

Transportation

The following are near-term recommendations advanced by the Transportation Subcommittee of the Campus Sustainability Committee (CSC) to set Duke on the right course to reduce transportation GHG emissions as presented in this report. These recommendations are separated by their respective principal transportation mode.

Commuter travel

- Duke should develop a comprehensive Transportation Demand Management program that utilizes the following tactics: carpool incentives; park and ride sites; and marketing, data collection, and analysis on commuter patterns
- Duke should study whether an affiliated housing program is feasible to incent commuters to chose location based on individual carbon footprint reductions
- Duke should engage on regional transportation issues such as regional transit, light rail/bus rapid transit (BRT) service and regional bike routes

Air travel

- Duke should create mechanism for better tracking of annual employee air travel, and develop air travel policies and guidelines using tactics such as: tracking air travel by distance and department, developing carbon awareness invoices for air travel by department to make individuals more aware of their air travel footprint, increasing use of alternative technology options such as web meetings or teleconferencing facilities, and educating employees about alternative travel arrangements such as carpooling, train, and bus

Campus fleet

- Duke should replace 10 buses to take advantage of efficiency gains of sixty-foot articulating, hybrid buses.

- Duke should encourage the utilization of local/regional transit through tactics such as: transit pass subsidy, advocating for improved local transit service and eliminating redundant service

- Duke should establish a "Green Policy" for fleet replacement to achieve vehicle efficiency/emissions improvements and right-size the Duke fleet with the goal to achieve 50% emissions reductions (factoring fuel efficiency gains)

Energy

The following are near-term recommendations advanced by the Energy Subcommittee of the CSC to address GHG emissions related to purchased electricity and steam production at Duke:

- Duke should push beyond the current LEED™ building policy to establish green building energy consumption standards and an approval protocol for building energy consumption review. Duke should implement, measure and report on energy use targets by Building Tech Rating

- Duke should implement, beginning in 2010, energy conservation measures (ECMs) in existing buildings with the goal to realize a 15% reduction in energy use over a 20 year period (2010 – 2030)

- Duke should discontinue the use of coal as soon as possible. Duke should complete the gas-fired East Plant steam plant construction and start-up in 2010 and initiate the West Campus steam plant conversion from coal in 2012

- Duke should continue to urge, monitor and review Duke Energy's progress towards emissions reductions while exploring on-campus electricity generation options. Additionally, Duke should install 4MW solar PV array by 2012

- Duke should leverage research into alternative technologies and explore and implement conversion to biogas, solar PV, solar thermal, combined heat and power or other technologies by 2030

- Duke should pursue plant efficiency improvements with tactics such as: distribution system upgrades, thermal storage, chilled water expansion and upgrade, and boiler plant heat recovery

Carbon Offsets

With respect to the purchase and/or development of carbon offsets, the Offsets Subcommittee of the CSC advanced the following recommendations to mitigate the remaining emissions following implementation of aggressive on-campus reduction strategies:

- Duke should establish an Carbon Offsets Initiative that will investigate the potential to develop an aggregating entity that could generate high quality, local offsets to meet Duke's and other university's neutrality goals

- Duke should balance fiscal risks and offset goals through a portfolio approach that considers: potential compliance obligations under a federal cap-and-trade or tax; credibility and measurability; cost; community and environmental co-benefits; links to education, research, and service (especially in environment, engineering, business, policy, and law); and mitigation of risk through a diversity of project types, suppliers and locations

- Duke University's offset portfolio should leverage its resources by:
    - Catalyzing offsets opportunities from local and southeastern US sources including partnerships with other NC and SC universities with similar climate neutrality commitments
    - Capitalizing on Duke's reach in the international research community and emphasizing global carbon offsets options
    - Maintaining an active role in project development, as opposed to a passive role as a purchaser
    - Engaging the full range of institutions and schools within its campus. In this capacity, the University should inventory the research, education, and initiatives across its schools and institutes that represent existing or potential engagement in the offsets 'value chain'. It should also identify win-win opportunities that reduce its footprint and further its educational, research and service mission

- Duke University's near term strategy should catalyze pilot offset projects and accelerate preliminary research in NC in at least the following categories:
    - **Swine Waste**—Duke should explore investment in reducing GHG emissions at three hog farms using the methane capture and waste conversion technologies modeled for the Nicholas Institute by Cavanaugh & Associates

    - **Forest Management and Afforestation**—Duke should combine its research with practical application with forest managers, including Duke Forest, NC State forest, and land trusts

    - **Energy Efficiency**—Energy efficiency could make a significant contribution to the Durham community and towards Durham's greenhouse gas commitments. Duke should suggest promoting energy efficiency in the community or amongst its employees at their homes, resulting in indirect emission reductions and significant energy cost savings

Education, Research and Community Outreach

The following are recommendations advanced by the Education Subcommittee of the CSC to describe plans to make sustainability and climate neutrality part of the educational experience

for all students; and plans to expand research and community outreach on sustainability throughout the institution.

- Duke should charge a campus committee to consider incorporating sustainability into the depth and breadth of the student experience. This group could consider tactics such as a "mode of inquiry" focused on environmental citizenship, literacy and sustainability or expanding existing efforts to integrate sustainability priorities into recruitment and orientation materials

- Duke should consider expanding programs to support two particular subsets of students: (a) students with a passion/interest in the environment, and (b) students with a professional interest in the environment and sustainability.

    - For students in group (a), tactics could include: expanding the peer-to-peer program, Students for Sustainable Living, or exploring new academic and service programs with sustainability themes, including FOCUS, seminars, DukeEngage, or study abroad

    - For group (b): tactics could include: exploring how existing or new certificate programs could provide evidence of knowledge of climate change and sustainability to potential employers and preparing students both for careers that are primarily in the area of climate change and sustainability, and for those where these concepts are infused or integrated into a job with other primary responsibilities

- Duke should continue to foster new and existing research efforts in sustainability and climate change. Tactics might include: establishing a conversation among researchers involved with sustainability and climate change, to determine the areas in which they see a need for increases in research and potential options to incentivize these endeavors

- Duke should continue to foster knowledge in service to society through creative partnerships in the local community

Communication

The following recommendations were advanced by the Communications Subcommittee of the CSC with the goal of moving beyond simply distributing information to promote changes in behavior among students, faculty and staff in ways that directly impact the reduction of greenhouse gas emissions at Duke.

- Duke should build community for grassroots engagement, through existing and new sustainability networks, to enhance awareness of campus sustainability efforts among internal audiences and the impact of their decisions on greenhouse gas emissions

- Duke should foster changes in behavior among internal audiences that reduce greenhouse gas emissions at Duke through tactics such as issuing campus challenges to change individual behavior and engaging community members at points of access

- Duke should set goals, measure and report on progress through tactics such as making climate change personal to the campus community with the development of a Duke specific carbon calculator and telling stories through the eyes of others

- Duke should enhance perception of the University internally and externally as a sustainability leader in higher education through tactics such as development of a sustainability media kit, branding the Climate Action Plan and developing an email engine to communicate sustainability initiatives

- Duke should leverage the University's unique attributes through research, sharing and implementing change in the local community

If Duke implements the recommended measures outlined above it will significantly reduce GHG emissions over time and be on track to meet its carbon neutrality goals.

Introduction

Climate change is one of the most critical issues facing today's society. The evidence and science are clear – climate change is a direct result of human activity and poses a significant threat to generations to come. The Intergovernmental Panel on Climate Change (IPCC) scientists believe that it is very likely (greater than 90 percent chance) that most of the warming experienced since the 1950s is due to the increase in greenhouse gas emissions from human activities.[3]

Since the industrial revolution, the burning of fossil fuels, such as coal and oil, and deforestation have caused the concentrations of heat-trapping "greenhouse gases" to increase significantly in the atmosphere. These gases create a warming effect, somewhat like a blanket surround the earth. The greenhouse effect is a natural occurrence that helps regulate the earth's temperature. This phenomenon is necessary to life as humans know it, because greenhouse gases keep the planet's surface warmer than it otherwise would be. But, as the concentrations of these gases continue to increase in the atmosphere, the Earth's temperature is climbing above past levels. According to NOAA and NASA data, the Earth's average surface temperature has increased by about 1.2 to 1.4ºF in the last 100 years. The eight warmest years on record (since 1850) have all occurred since 1998. Other aspects of the climate are also changing such as rainfall patterns, snow and ice cover, and sea level.[4]

If greenhouse gases continue to increase at or above the current pace, climate models predict that the average temperature at the Earth's surface could increase from 3 to 7ºF above 1990 levels by the end of this century.[5] Scientists are certain that human activities are changing the composition of the atmosphere, and that increasing the concentration of greenhouse gases will change the planet's climate, but they are not sure by how much, at what rate, or what the exact effects will be.[6]

The potential effects of climate change could have significant and irreversible impacts to human health and the planet. Fresh water shortages, sea level rise, droughts, floods, severe hurricanes, reduced agricultural production and the spread of insect-borne and waterborne diseases are just a few of the predicted results of rising global temperatures. The consensus among climate scientists is that to avoid the most severe consequences of global warming, global emissions of greenhouse gases need to peak no later than 2015 and decline rapidly thereafter to a level between 50 and 85 percent below 2000 levels by 2050. The leadership and effort necessary to adapt to unavoidable climate change while simultaneously reducing emissions to these levels

[3] IPCC "AR4 WG1 FAQs" 2007, http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Print_FAQs.pdf; IPCC Climate Change 2007, : WGI Summary for Policy Makers, http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Print_SPM.pdf
[4] http://www.epa.gov/climatechange/basicinfo.html. 2009
[5] IPCC Climate Change 2007: The Physical Science Basis, http://ipcc-wg1.ucar.edu/wg1/wg1-report.html
[6] http://www.epa.gov/climatechange/basicinfo.html. 2009

are major challenges that require unprecedented cooperation and participation across the world.[7]

As world leaders and individuals alike struggle to comprehend the scope of global climate change and how to reduce emissions locally, Duke University has joined with hundreds of other colleges and universities across the U.S. to focus the research and leadership of higher education on this pressing issue. In June 2007, Duke President Richard H. Brodhead signed the American College & University Presidents Climate Commitment (ACUPCC) and with this action committed the university to develop institutional plans to achieve climate neutrality or net zero greenhouse gas emissions.

This initiative is a part of Duke's deep-rooted culture of public engagement and the belief that the University has the duty to share the knowledge of faculty and students to address pressing global issues. Tackling the complex problem of climate change here at Duke not only benefits this institution but society as a whole. To solve the pressing environmental and social issues facing the world, it will take the participation and inspiration of the entire society, and the world is looking to institutions of higher education for leadership and innovation. Duke University is confident in its ability to address the campus climate footprint as it strives to educate the next generation that will build a sustainable future.

Tackling Climate Neutrality at Duke

Since signing the ACUPCC in 2007, campus stakeholders at Duke have been working together to set targets, strategies and time tables to achieve this initiative. This project touches many elements of the campus that significantly affect Duke's ecological footprint, including transportation, energy use and campus fuels, waste reduction and individual behavior.

To guide the development and implementation of the campus Climate Action Plan, President Brodhead asked Executive Vice President Tallman Trask and Bill Chameides, Dean of the Nicholas School of the Environment, to co-chair a Campus Sustainability Committee (CSC). The CSC includes representative faculty, students, and operational staff including sustainability director Tavey Capps who manages the work of the committee (See Appendix A for a full list of CSC members).

The initial charge of this committee is two-fold. First, the committee has been responsible for gathering data, and analyzing and defining Duke's overall greenhouse gas emissions. Secondly, the CSC has focused on developing a clear Climate Action Plan (CAP) to reduce the three main sources of Duke's greenhouse gas emissions: electricity usage, the campus steam plant, and transportation, as well as communicating Duke's efforts to address climate change and how individual behavior impacts success.

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[7] Pew Center on Global Climate Change. Pew Center on the States. "Climate Change 101: Understanding and Responding to Global Climate Change." 2009. http://www.pewclimate.org/docUploads/Climate101-Overview-Jan09.pdf

The CAP includes the target date and interim milestones for achieving climate neutrality, strategies and mitigation projects that will allow Duke to reach its target, and mechanisms for tracking progress on goals and actions. While the University intends to take aggressive action toward on-campus carbon reduction, it accepts the reality that GHG offsets, emissions reductions or sequestration purchased or produced outside Duke's own footprint, will be a part of the overall climate neutrality plan. The CAP will also focus on how to ensure all students graduate from Duke with an understanding of sustainability and that the entire campus community is engaged in this ambitious institutional effort to address climate change.

To facilitate the planning process, the CSC formed working groups around five specific focus areas – transportation, energy, offsets, education and communication. The expectation and objectives of these subcommittees include:

1) Energy & Transportation Subcommittees
    a. Update existing campus GHG inventory including review of past data, verify boundaries and what to include
    b. Develop potential reduction options to evaluate, reporting back to CSC as they go through evaluation progress
    c. Develop recommendations for climate neutral target dates and reduction strategies to achieve targets

2) Offset Subcommittee
    a. Research opportunities for offset investment in the Triangle region and NC
    b. Develop recommendations on the feasibility and opportunities for local offset projects
    c. Develop recommendations on the source and quantity of offsets to meet Duke GHG reduction targets

3) Education Subcommittee
    a. Research existing curricular and co-curricular opportunities for environmental education at Duke
    b. Develop recommendations to make climate neutrality part of the educational experience for all students
    c. Develop recommendations to expand research and community outreach on sustainability

4) Communications Subcommittee
    a. Develop a communication strategy to educate internal and external audiences about Duke's efforts to address climate change
    b. Create an expert list for media, take advantage of existing relationships with media and trade publication contacts, and further develop opportunities to illustrate Duke as a sustainability leader
    c. Develop recommendations on strategies to engage Duke students, faculty and staff in campus sustainability efforts

Duke's Greenhouse Gas Footprint

Assessing the impact and magnitude of Duke's GHG footprint is not a new phenomenon for the university. The first campus GHG inventory was conducted in 2004 using software distributed by Clean-Air Cool-Planet, a non-profit organization out of Portsmouth, NH (www.cleanair-coolplanet.org/). Emissions were tracked back to 1990 in order to view the trends over time. The goals of the inventory were to determine the extent of Duke's GHG emissions, characterize the major sources and examine trends in emissions over the last fourteen years. The scope of the inventory included all campus operations, including both health system as well as the university. The 2008 Duke GHG inventory, the first key milestone of the ACUPCC, followed a similar methodology as the previous inventory, with some minor changes.

2008 GHG Inventory

Methodology

The 2008 Duke GHG inventory was conducted during the summer of 2008 to update the previous campus inventory and provide the baseline for Duke's overall ACUPCC Climate Action Plan. Once again the Clean-Air Cool-Planet software was used for the basis of analysis. The boundaries of the inventory included "Duke proper" – the university and health system buildings on or adjacent to the Durham Campus and the Beaufort Marine Lab. The inventory did not include leased space or satellite health system buildings and hospitals. The boundaries were decided by the Campus Sustainability Committee based on the ability to affect areas of campus and the level of control the central administration had over these units.

Sources of Emissions Inventoried

Consistent with GHG Protocol standards, signatories of the ACUPCC are expected to track and report emissions of the six greenhouse gases covered under the Kyoto Protocol: carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF6). Signatories are expected to calculate the emissions of each gas separately, and aggregate them into units of carbon dioxide equivalents (CO2-e) on the basis of each gas' global warming potential (GWP)[8]. To help delineate emission sources, improve transparency, and provide utility for different types of organizations and different climate policies and goals, the GHG Protocol defines three "scopes" for GHG accounting and reporting purposes.[9] The accepted designation categories include:

- Scope 1 - direct GHG emissions occurring from sources that are owned or controlled by the institution. Ex. campus steam plant, fleet vehicles, and "fugitive emissions" such as leakage of HFCs from refrigeration equipment

[8] Global warming potential refers to the total contribution to global warming over a certain time horizon resulting from the emission of one unit of gas relative to one unit of carbon dioxide. For example, if methane has a global warming potential of 21 over a 100 year time horizon, it means that over a period of 100 years, 1 lb .of methane has the same impact on climate change as 21 lbs. of carbon dioxide and thus 1 lb. of methane would count as 21 lbs. of carbon dioxide equivalent.

[9] ACUPCC Implementation Guide v.1. September 2007.

- Scope 2 – indirect emissions generated in the production of electricity consumed by the institution. Ex. Duke Energy usage

- Scope 3 – refers to all other indirect emissions that are a consequence of the activities of the institution, but occur from sources not owned or controlled by the institution. The ACUPCC requires institutions to include scope 3 emissions from commuting and from air travel paid for by or through the institution. Commuting is defined as travel to and from campus on a day to day basis by students, faculty, and staff. It does not include student travel to and from campus at the beginning and end of term or during break periods.

Under the strictest definition, Duke's GHG inventory would only include Scope 1 emissions or emissions directly owned or controlled by the University. However, in order to get a better sense of Duke's entire GHG impact and to meet the guidelines of the ACUPCC, Scope 1, Scope 2 and particular Scope 3 emissions have been included in the campus inventory.

GHG Emissions Included in 2008 Inventory

Scope 1 emissions		
		Sources of data
West Campus steam plant fuel		Coal, natural gas and fuel oil consumption
Fleet vehicle fuel		
	Gasoline	University BP gas cards, Facilities purchases, University Police purchases, West Campus Grounds purchases
	Diesel	Gallons sold at Transit fueling station
Refrigerants		Estimated from Facilities and Engineering & Operations purchasing data minus current inventory
Fertilizer*		Usage data from Facilities, Washington Duke Inn, Athletics, and Duke Gardens; nitrogen content averaged across all four sources
Scope 2 emissions		
Duke Power electricity usage**		Used five main Duke Power accounts, counts for 95% of the electricity usage, included Marine Lab
Scope 3 emissions		
Employee air travel*		Used Duke's American airlines data for FY06 and FY07 to get an average price per mile; Took Employee Travel and Reimbursement financial data on air travel purchases / avg. price per mile
Employee commuting		Used 2006 and 2008 Triangle Transit Authority (TTA) survey data for mode share; Used a straight-line analysis of employee address data to estimate an average daily commute distance

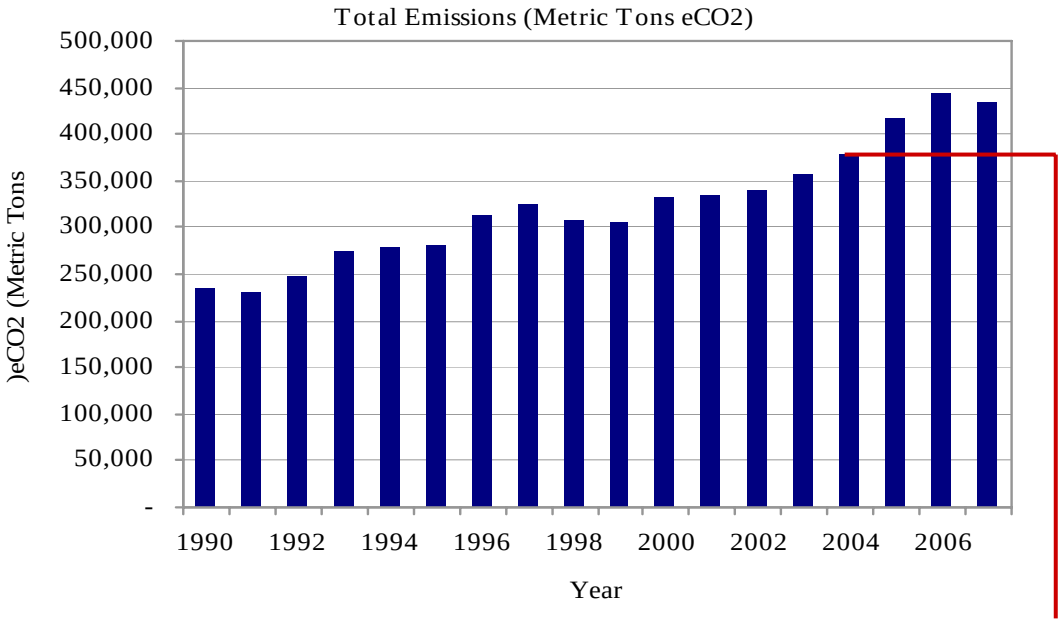
Student athletic team travel		Data from Athletics on team flights
Solid Waste		
	Landfilled solid waste	Data from Grounds department
	Incinerated medical waste	Data from Occupational and Environmental Safety Office
Other sources included		
Duke Forest preservation		Sequestration potential hasn't changed since 2004, forest management and size has stayed the same
Composting		Data from Grounds department
REC purchases		Data from professional schools that purchased wind RECs

*Not included in previous 2004 GHG inventory

** Updated emission factors in CACP spreadsheet based on specific Duke Power emissions for Carolinas region

Inventory Analysis

Consistent with national trends, Duke's GHG emissions have been increasing over the past 17 years. In FY07, Duke's total GHG footprint was 433,961 metric tons of CO2e, an increase of 15 percent since the 2004 inventory. However, it should be noted that the methodology and emissions included in the 2008 inventory are not completely consistent with the 2004 analysis. While useful to look at the overall emission trends, adjustments to emissions factors and the inclusion of new data sources such as employee air travel make it difficult to compare the two inventories directly against one other.



2004 levels = 377,489

+ 10.5%

2005 levels = 416,951

+ 6.5%

2006 levels = 444,002

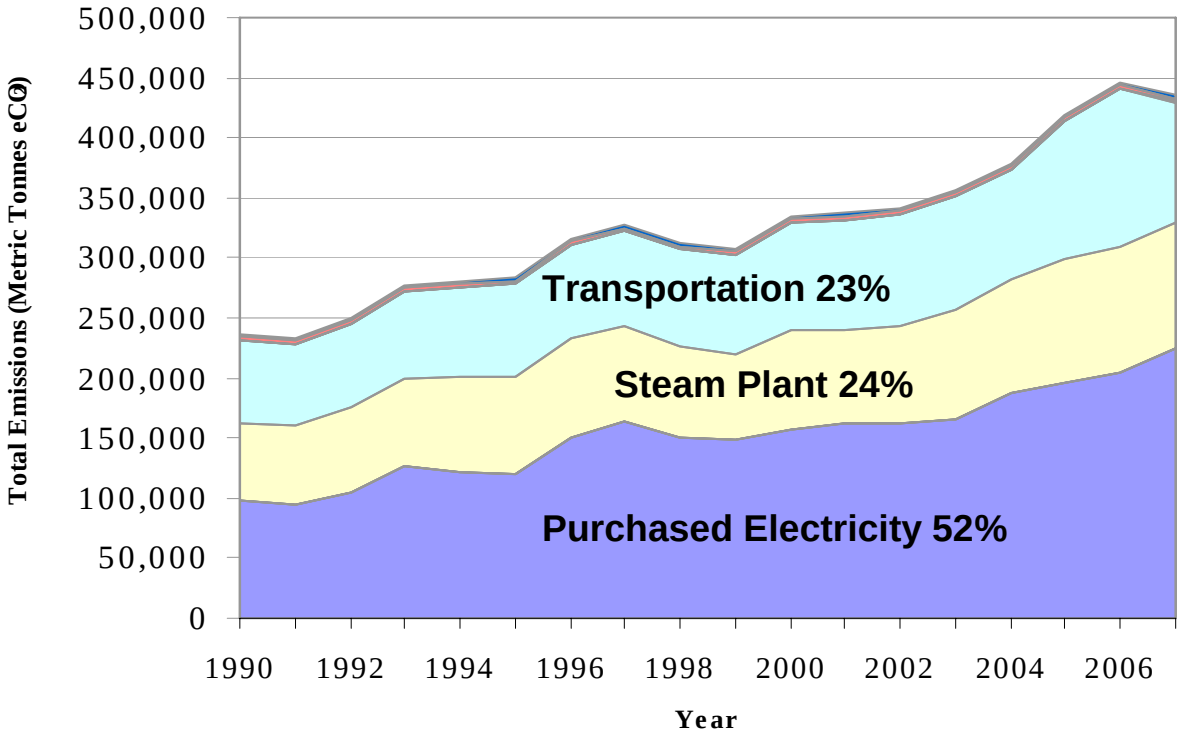
- 2.3%

2007 levels = 433,961

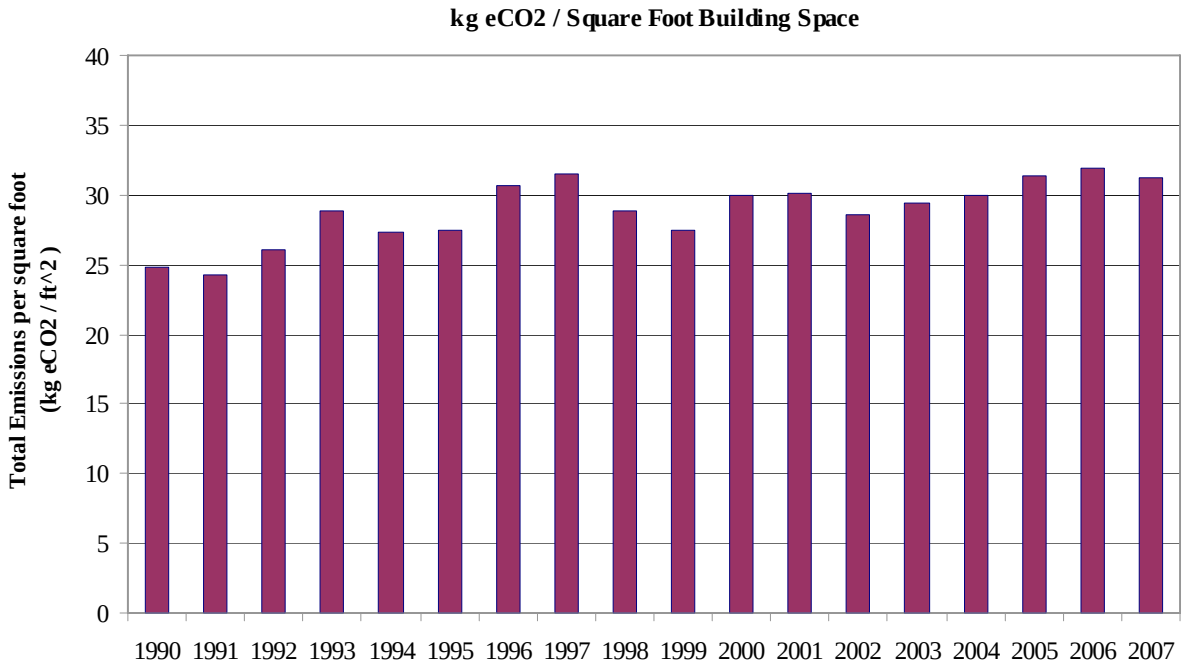
15% increase since 2004

It should also be noted that the reduction in overall emissions from FY06 to FY07 is primarily a result of new employee commuting numbers. In 2004 and in 2008, a straight-line analysis of employee address data was used to estimate an average daily commute distance. The conclusion was 15 miles and 9 miles respectively. However, in the 2008 inventory, employees from the satellite hospitals, Duke Raleigh and Durham Regional, were removed from the calculations. Therefore, it is hard to determine if employees are really choosing to live closer to Duke or if the change in methodology resulted in the reduction in average commute distances.

Operationally, the main sources of Duke's GHG emissions are electrical usage, the campus steam plant, and transportation. These account for over 99% of campus emissions. Less than 1% comes from fertilizer usage, solid waste and refrigerants. As the campus has grown over time, this ratio of emissions sources has remained mostly consistent.



Another interesting trend over the past few years is the institutions carbon emissions per square foot, or carbon intensity. Despite institutional growth of over one million gross square feet the carbon intensity of the campus, has remained relatively constant. Since 2003, Duke has required all new construction and significant renovation to be LEED certified with a goal of silver. While these energy efficient buildings improve the overall campus carbon intensity, other factors such as increasing electrical plug loads in buildings could be working against this trend. The energy subcommittee of the CSC has determined this topic needs further study.

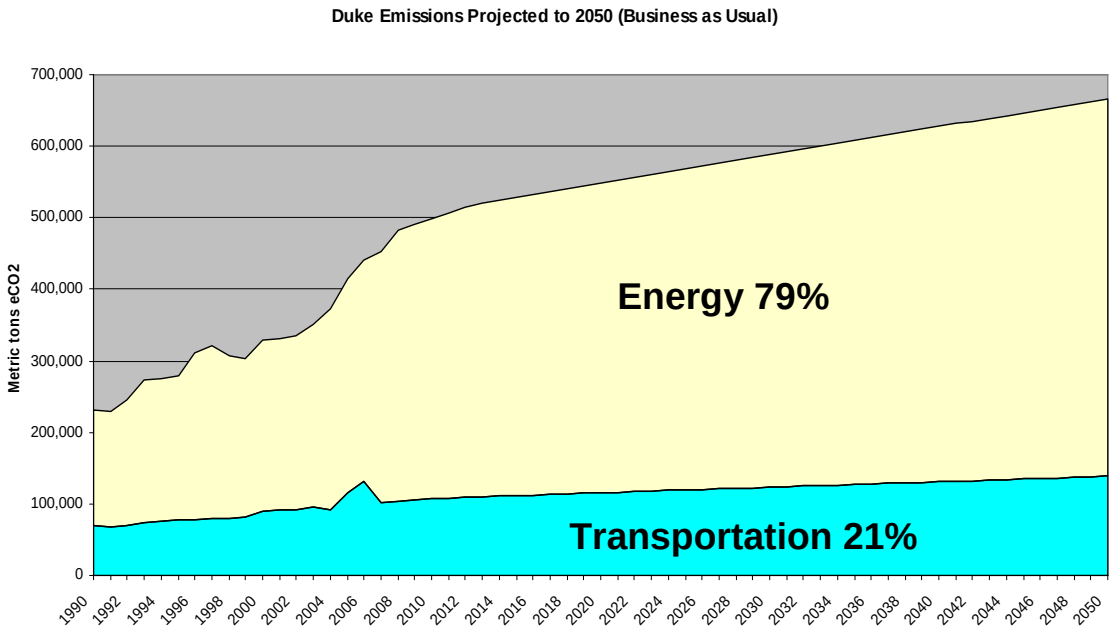


2004 = 30.0 2005 = 31.3 2006 = 32 2007 = 31.2

The 2008 Duke GHG inventory provided the CSC with an updated foundation to begin the rigorous task of developing a Climate Action Plan that would move Duke to climate neutrality. 2007 has been chosen as the baseline year for future reduction primarily due to the changes made in the inventory methodology. Comparing emissions back to 1990 or even the previous inventory of 2004 would not provide a true representation of emission reduction efforts. Additional analyses of particular GHG emissions trends are included in subsequent sections by source.

Estimated Future GHG Emissions

For the purpose of this analysis, Duke has also modeled where the campus emissions trajectory would go if left to grow unchecked into the future. Assuming there are no reduction measures taken at Duke and no external factors such as carbon legislation or increased fuel economy standards are implemented, Duke's emissions would grow to 668,608 metric tons of CO2e by 2050. Campus steam production and purchased electricity would combine for 79 percent of the emission footprint. The other 21 percent would come from transportation activities. This "business-as-usual" scenario, even taking into consideration the recent economic downturn and reduced campus construction, represents a 54 percent increase in Duke's emissions.



When put into these terms, the need for proactive GHG reduction strategies is even more apparent at Duke. It is the purpose of this Climate Action Plan to outline the specific actions, within campus energy use and transportation activities, that can be implemented to reduce and ultimately reverse this business-as-usual trend.

Transportation

Summary Recommendations

The following are near-term recommendations advanced by the Transportation Subcommittee of the Campus Sustainability Committee (CSC) to set Duke on the right course to reduce transportation GHG emissions as presented in this report. These recommendations are separated by their respective principal transportation mode.

Commuter travel

- Duke should develop a comprehensive Transportation Demand Management program that utilizes the following tactics: carpool incentives; park and ride sites; and marketing, data collection, and analysis on commuter patterns
- Duke should study whether an affiliated housing program is feasible to incent commuters to chose location based on individual carbon footprint reductions
- Duke should engage on regional transportation issues such as regional transit, light rail/bus rapid transit (BRT) service and regional bike routes

Air travel

- Duke should create mechanism for better tracking of annual employee air travel, and develop air travel policies and guidelines using tactics such as: tracking air travel by distance and department, developing carbon awareness invoices for air travel by department to make individuals more aware of their air travel footprint, increasing use of alternative technology options such as web meetings or teleconferencing facilities, and educating employees about alternative travel arrangements such as carpooling, train, and bus

Campus fleet

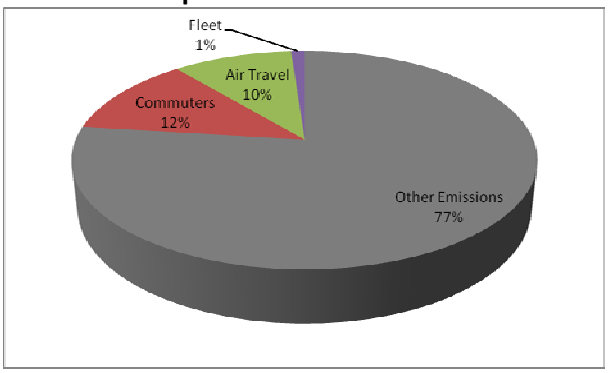
- Duke should replace 10 buses to take advantage of efficiency gains of sixty-foot articulating, hybrid buses.
- Duke should encourage the utilization of local/regional transit through tactics such as: transit pass subsidy, advocating for improved local transit service and eliminating redundant service
- Duke should establish a “Green Policy” for fleet replacement to achieve vehicle efficiency/emissions improvements and right-size the Duke fleet with the goal to achieve 50% emissions reductions (factoring fuel efficiency gains)

The following section describes the baseline assumptions used in the existing GHG emissions inventory of transportation-related activities at Duke; overviews the existing transportation conditions; outlines possible GHG reduction alternatives through transportation demand management and/or operational changes; and presents a wedge analysis of the most viable transportation measures that Duke University might implement to achieve the transportation goals of its GHG reduction program.

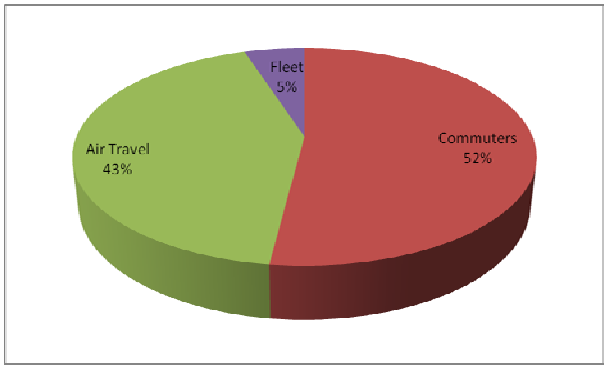
Background

The 2007 GHG inventory established that approximately 23 percent of Duke's GHG emissions were transportation related. Three main components contribute to these emissions: commuter-related travel; institution sanctioned and financed air travel; and service and transit fleet related activity The contributions of these elements to Duke's transportation and overall GHG emissions are depicted in Exhibit 1.

Exhibit 1 Transportation-Related Emission Contributors



Overall



Transportation Only

As a foundation for its climate action plan, Duke University is evaluating its transportation system's operation, alternatives, and policies to reduce the amount of GHGs emitted by its commuter activity, air travel, and campus fleet. Through quantitative and qualitative evaluation, Duke is developing an effective transportation plan that reduces its carbon footprint and works within the context of its vibrant campus and activities and transportation system serving Durham, North Carolina.

To inform this analysis, Duke has examined existing campus transportation conditions to provide context and help shape the opportunities and challenges in developing more environmentally friendly transportation alternatives in the future. (See Appendix B). The University has also reviewed existing commute options for the campus community.

Duke University and local and regional agencies operate many programs to encourage the use of alternative modes of transportation: Rideshare, Carpooling, Bicycling/Walking, Telecommuting, Vanpooling, Guaranteed Ride Home, Zipcar, and local and regional Transit. One of the roles of the University's Parking and Transportation Services is to reduce traffic congestion, reduce fuel consumption and negative environmental impacts, and to improve the quality of life for commuters through savings on travel expenses, allowing better use of time during commuting hours, and by improving the health of the commuters. All of these programs are described in detail in Appendix B. Based on the availability of alternative modes of transportation described above, the current mode use of Duke University campus and health system employees are provided in the Exhibit 9.

Exhibit 9 Duke University Baseline Mode Share

Mode	GHG Effects	Main Campus (%)	Health System (%)	Overall (%)
Drive Alone	***Most Impacting***	72%	83%	77%
Carpool		11%	9%	10%
Vanpool		<1%	<1%	<1%
Transit		4%	3%	3%
Bicycle		5%	1%	5%
Pedestrian	***Least Impacting***	4%	1%	4%
Other		3%	2%	1%
Total		100%	100%	100%

With respect to GHG emissions, driving alone is the most impacting mode of commuting vehicle while walking is the least impacting.

Based on the input from the Duke University GHG Transportation Sub-committee, the Duke Transportation Advisory Committee and research conducted on peer institutions, several potential GHG reduction options were identified and reviewed in a cursory fashion to understand how effectively they would operate in the Duke University setting. These alternatives were grouped by the three largest contributors to transportation related greenhouse gases: commuters, air travel, and fleet vehicle use. See Appendix B for a detailed listing of options and an analysis of their effectiveness for Duke.

Wedge by Wedge GHG Analysis

A wedge analysis provides a visual representation of greenhouse gas reductions due to program implementation or events over time. Each principal transportation segment, Commuter, Air Travel, and Fleet, was evaluated using a wedge analysis to understand the long-term benefits of each program and to estimate the long-term GHG reductions. This report presents the composite findings for the Duke University main campus and health services components. Detailed analyses broken down by these constituent groups are also provided in the Appendix to this report.

Assumptions

To establish a future baseline condition for evaluation, the following assumptions were made:

- Duke University academic functions grow at a rate of 27,000 square feet (SF) per year over the next 5 years and 50,000 square feet per year thereafter, at an average occupancy of 2 persons per 1000 SF;
- Duke University health services grow at a rate of 169,000 square feet per year over the next 5 years and 50,000 square feet per year thereafter at an average occupancy of 4 persons per 1000 SF; and,
- No strategies for transportation demand management have been implemented.

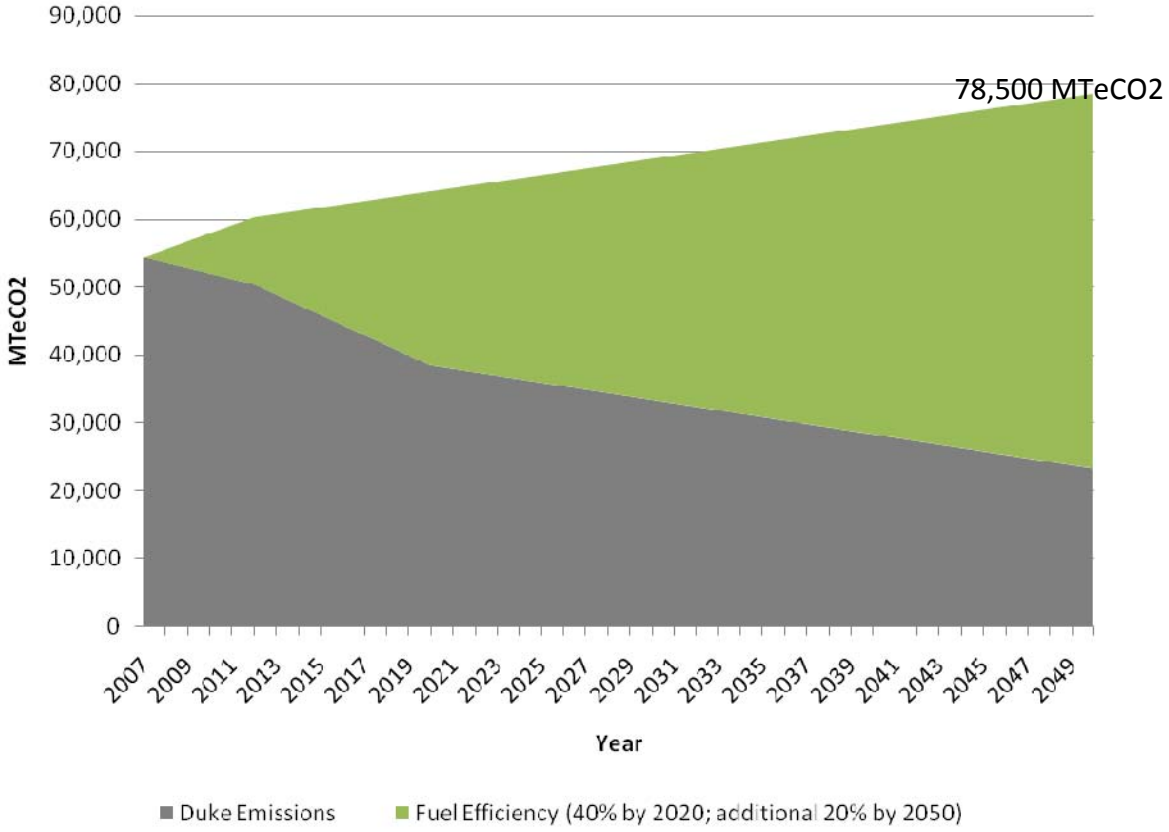
These assumptions were used to forecast the overall Duke transportation-related emissions to the year 2050.

Commuter Wedge

Commuter-related emissions were approximately 53,000 MTCO2e in 2007 and increases to approximately 78,500 MTCO2e in 2050 without the influence of external factors or policies to influence current behavior.

Independent of any Duke-related action, a significant percentage of the commuter emission reductions is due to improvements in vehicle fuel efficiency. These assumptions were made based on the Energy Independence and Security Act (P.L. 110-140, H.R. 6) passed into law in 2007 which increases Corporate Average Fuel Economy (CAFE) standards to 35 miles per gallon by 2020[10]. It is reasonable to believe that these fuel efficiency standards will increase by at least an additional 20 percent by the year 2050[11]. A 60 percent increase in fuel efficiency over existing standards is still below standards set in Japan and Europe for the year 2020[12]. This external force is incorporated into the "Business as Usual" (BAU) condition depicted in Exhibit 25.

Exhibit 25 Business as Usual Commuter-related GHG Emissions



[10] *CRS Report for Congress: Energy Independence and Security Act of 2007: A Summary of Major Provisions*, December 21, 2007.

[11] These numbers do not take into account the recent changes in national CAFE standard enacted by President Obama in May 2009. However, the new standard would only impact fuel economy estimates before 2017.

[12] Technology Review, *The New CAFE Standards: Fuel standards will likely be achievable but won't encourage innovation,* Peter Fairley, January 15, 2008.

In order to reduce commuter related emissions from the BAU condition, an aggressive Transportation Demand Management (TDM) program, as presented above, can help reduce emissions. In addition, other Duke initiated programs will help reduce emissions further. Furthermore, several anticipated local and regional transportation infrastructure projects and emissions reduction technologies will reduce commuter related GHG emissions further. The following are the programs, infrastructure improvements, and emissions reduction technology assumed to be implemented as part of this analysis.

- Near to Mid-Term (Years 1-20)
    - Transportation Coordinator
    - Marketing Program
    - Parking Pricing Increases
    - Full Transit Subsidy
    - Carpool Incentive ($200)
    - Park and Ride
    - Improved Local (DATA) Transit Service
    - Commuter Vehicle Fuel Efficiency (assume 40% improvement by 2020)*
- Long Term (Years 20+)
    - Light Rail/BRT Service
    - Commuter Vehicle Fuel Efficiency (assume additional 20% improvement by 2050)**
    - Affiliated Housing (assumes 1,500 Single Occupancy Vehicle (SOV) Commuters)

Exhibit 26 presents the reduction programs, infrastructure improvements, and emissions reduction technology and their respective of commuter related emission reductions. The overall reduction percentage for each component is provided in the right margin.

Exhibit 26 Total Duke Commuter-Related GHG Emission Reductions

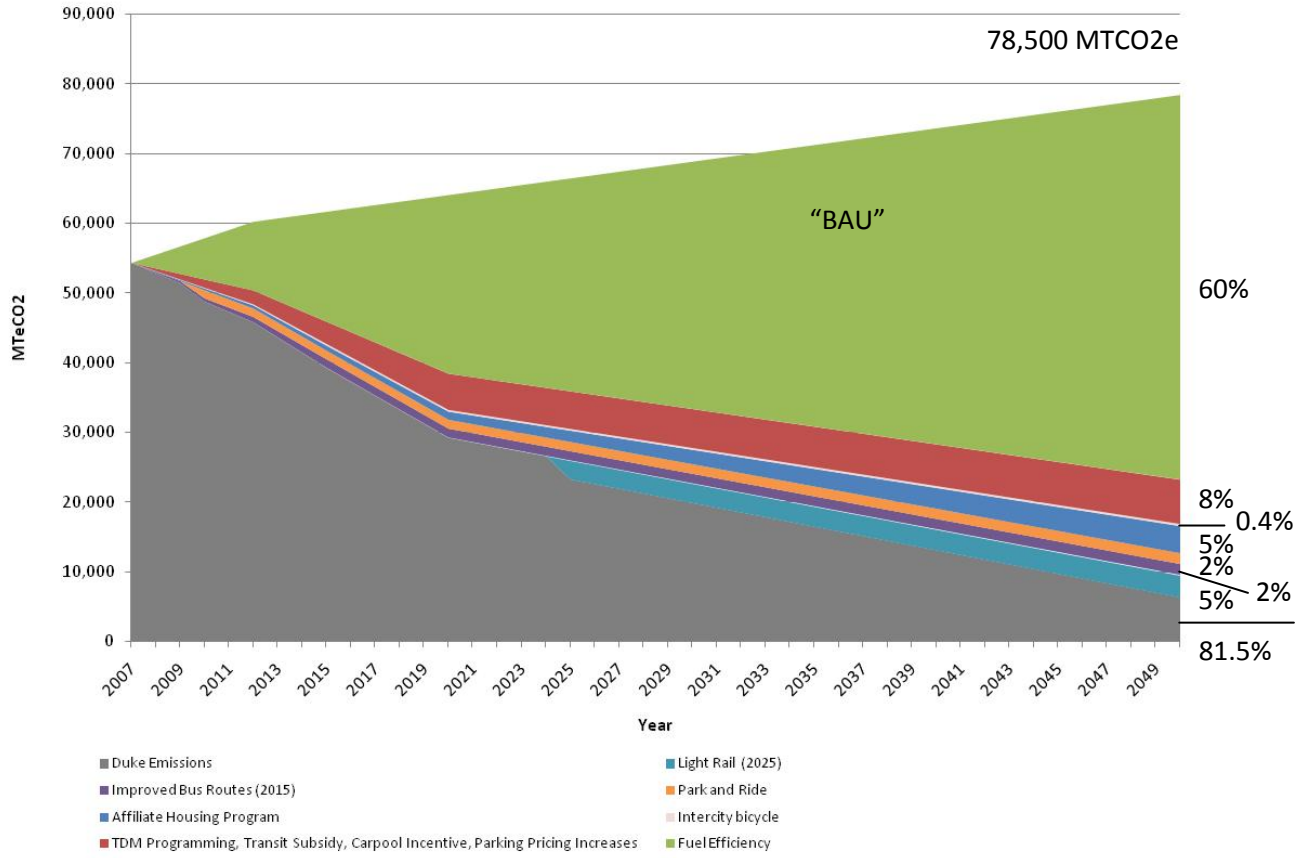


Exhibit 27 presents the estimated mode split shift based on full implementation of the commuter emissions reduction program.

Exhibit 27 Estimated Mode Split Shift

2007		Full Program Implementation (2050)	
77%	Drive Alone	45%	Drive Alone
10%	Carpool/Rideshare	20%	Carpool/Rideshare
3%	Bicycle	7%	Bicycle
3%	Walk	5%	Walk
3%	Transit (Bus)	19%	Transit*
3%	Other	3%	Other
<1%	Vanpool	<1%	Vanpool

*Includes Park and Ride

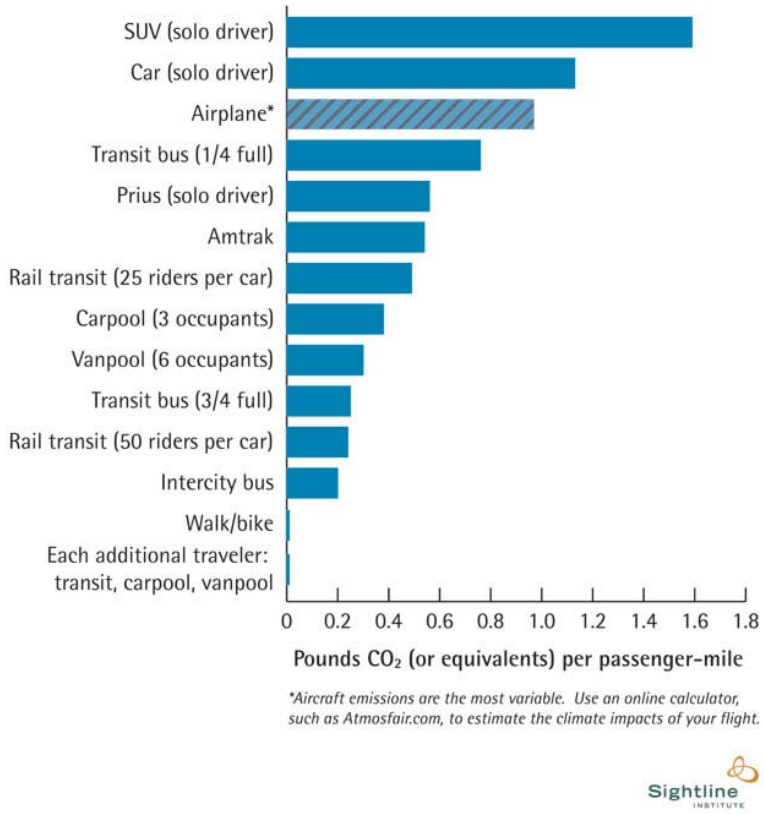
As shown, should all of the elements presented in Exhibit 26 be implemented, it is anticipated commuters that drive alone to Duke will be reduced from 77 percent to 45 percent. Due to the significant transit infrastructure improvements, it is anticipated that the transit use will grow to 19 percent.

Air Travel Wedge

Approximately 43 percent (43,400 metric tons) of all of Duke's transportation related emissions are estimated to be associated with air travel. This translates into about 10 percent of Duke's overall emissions on an annual basis. Duke air travel-related emissions increase to approximately 54,000 MTeCO2 in 2050 without the influence of external factors or policies to influence current behavior. This estimated increase is based on the estimated rate of growth in campus and health services populations.

On a per passenger mile basis, air travel is recognized as one of the most damaging to the climate of all travel modes. The Sightline Institute, based in Seattle, has done considerable research into the climate effects of the various modes of transportation and has compiled the following comparison to illustrate the relative effects that travel choice has on CO2 emissions (see Exhibit 14).

Exhibit 14 Effects of Travel Choice on C02 Emissions



Source: The Sightline Insitute

While useful, the chart above is slightly misleading in that it does not consistently present vehicle occupancy. For example, while the plane travel calculations assume an average passenger load factor, the automobile travel assume a single occupant. This is particularly not the case for longer distance automobile travel where vehicle occupancies tend to be 2 persons or more. When factored into the calculations, this generally shows that car travel for

comparable economy class air travel trips (for an average car that gets 20 miles per gallon)tend to emit about 40 percent less emissions per passenger mile traveled.

Air travel is an important component of the emissions reduction plan to consider because of its share of the overall Duke University emissions inventory and for the intensity of greenhouse gases emitted by airplanes. To put this in some perspective, round trip airplane travel between Raleigh-Durham and Washington, DC produces approximately 0.16 metric tons of CO2 emissions per passenger trip. That makes this one trip equivalent to about 50 commuter trips to or from the Duke campus. However, air travel demand for academic institutions is also difficult to manage since so much of the need to travel is directly related to the academic mission of the university, advancement of its faculty and staff, and propagation of its reputation. Specific obstacles to reducing air travel demand that have been cited by Duke constituents, as well as academics from similar institutions, are:

- The need to be present at academic meetings and conferences to collaborate with colleagues across academia and industry;
- The need to maintain visibility for the University in the various research arenas;
- The need to recruit students and faculty;
- Accommodating athletic programs and schedules;
- The need to meet with alumni and potential benefactors; and,
- The need to attend various administrative and training meetings.

Investigation and conversations held during the course of this study also revealed that:

- There is limited awareness of the environmental consequences of air travel by Duke constituents;
- There is no formal accounting for air travel usage by department or trip purpose or destination; and
- For many trips, there are limited options for alternative (and less damaging) modes of transport.

The "Business as Usual" condition for future air travel emissions should factor in expected operational and technological enhancements in the airline industry. Key assumptions factored into this analysis include the following:

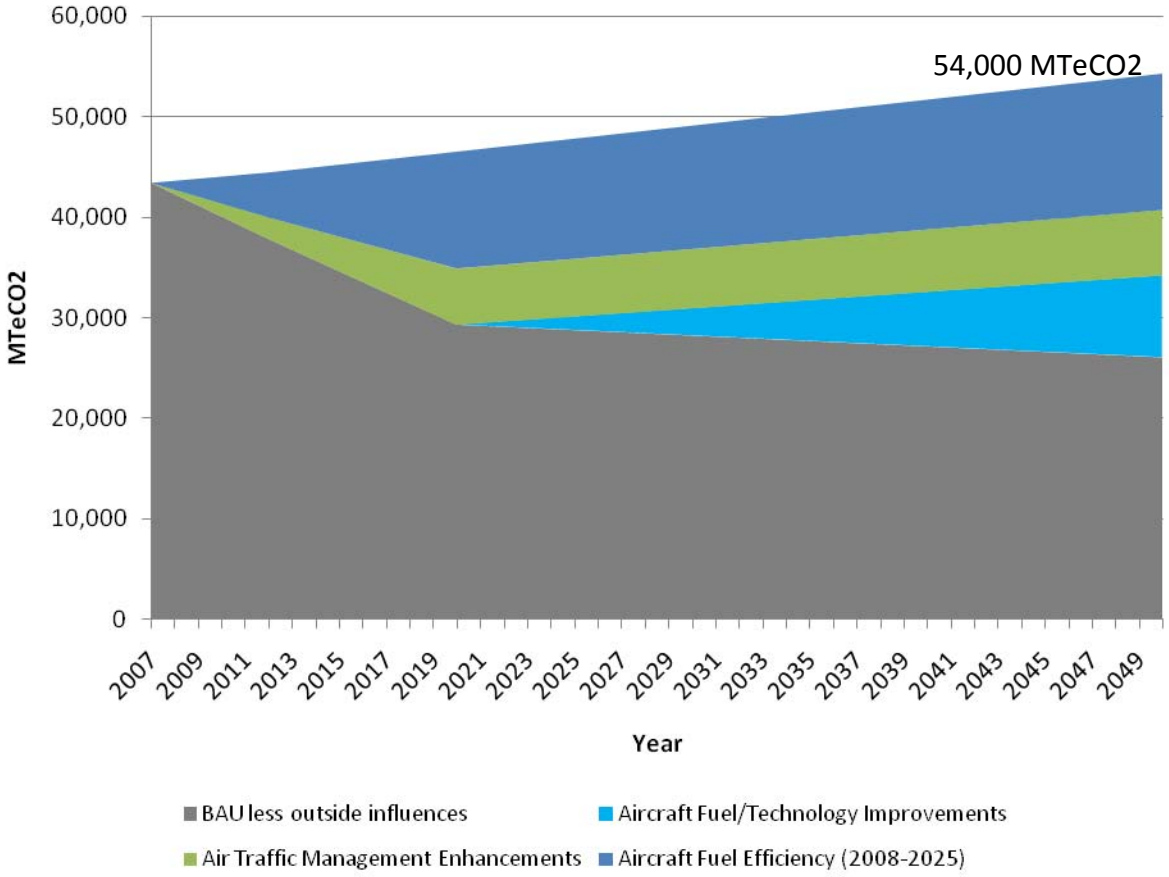
- Near to Mid-Term (Years 1-20)
    - Measures, as examples, might include:
        - Increasing awareness of technology capability through the Office of Information Technology;
        - Promoting alternative travel arrangements (Carpooling, Train, Bus); and
        - Carbon awareness invoices issued to departments.
    - Aircraft Fuel Efficiency (assume 25% by 2020)[13]

[13] http://www.iata.org/whatwedo/environment/fuel_efficiency.htm

    - Air Traffic Management Enhancements (assume 12% by 2020)
- Long Term (Years 20+)
    - Aircraft Technology Improvements (assume additional 15% from 2020 to 2050)

Exhibit 28 presents the "Business as Usual" outlook on air travel related GHG emissions.

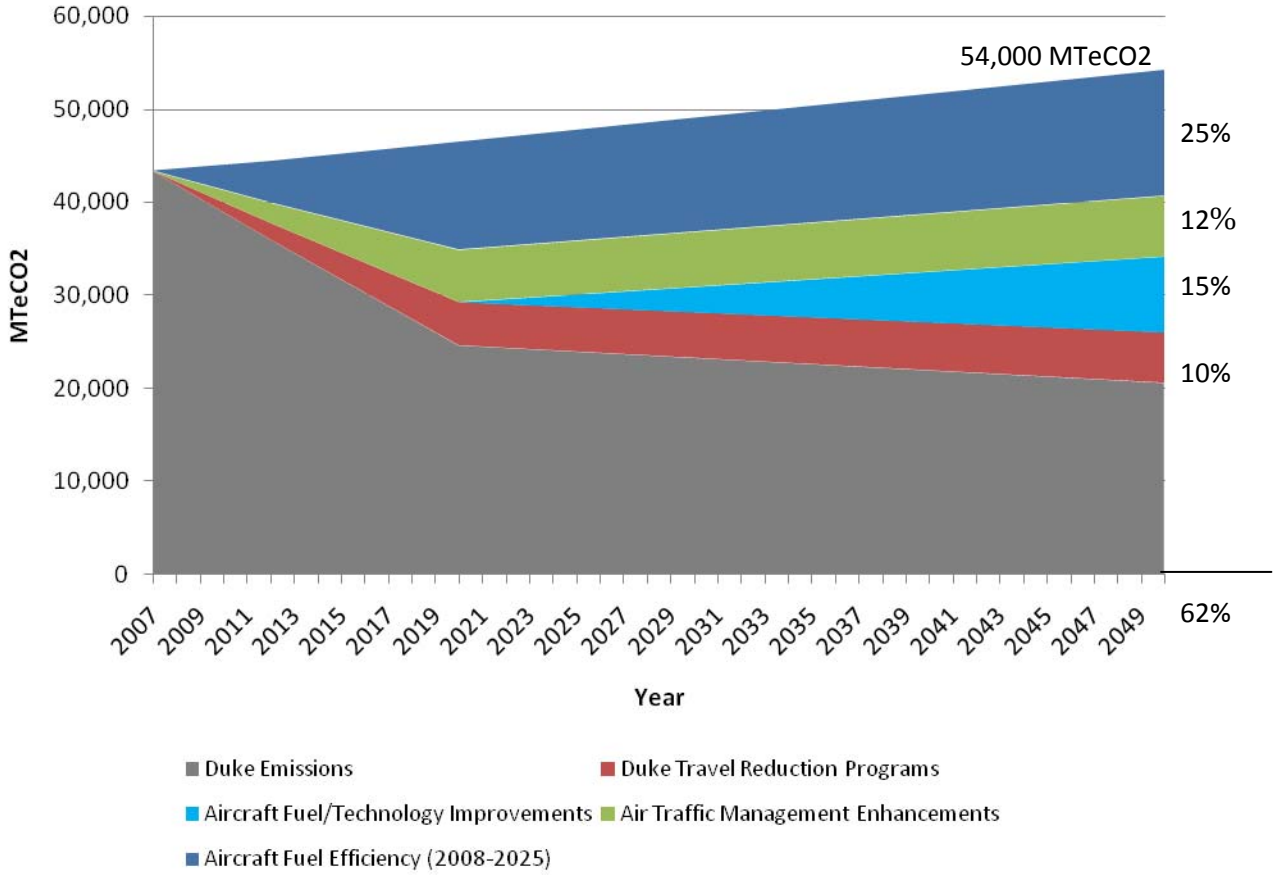
Exhibit 28 Business as Usual Air Travel-related GHG Emissions



A mandated reduction in air travel imposed by the administration on departments is unlikely due to the importance of this travel to the livelihood and mission of the University. However, a travel policy and guideline for air travel and a promotion of alternative forms of travel/meeting mode can have a significant effect on overall air travel trip reductions.

Exhibit 29 presents the overall air travel related reductions. The overall reduction percentage for each component is provided in the right margin.

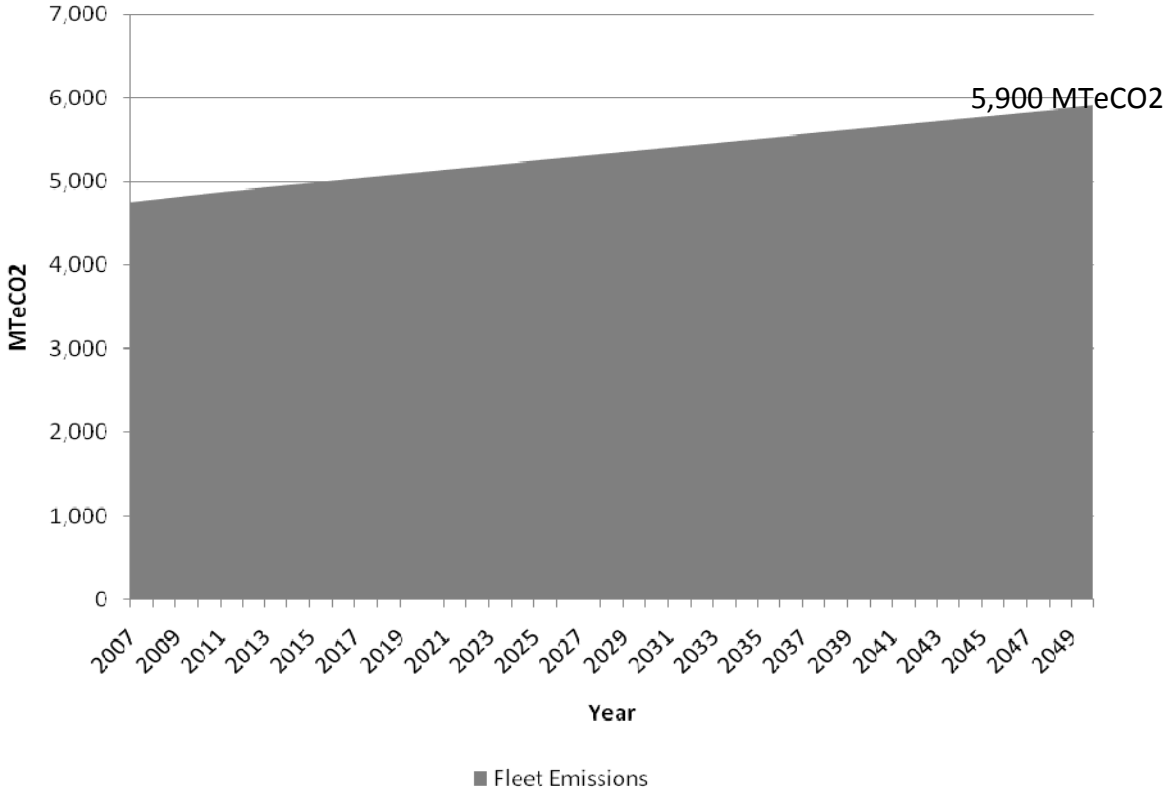
Exhibit 29 Total Duke Air Travel-Related GHG Emission Reductions



Fleet Wedge

Fleet related emissions were approximately 4,800 MTCO2e and increases to approximately 5,900 MTCO2e in 2050 without the influence of external factors or policies to influence current behaviors. This estimated increase is based on the estimated rate of growth in campus and health system populations. While fleet operations (both service vehicles and transit vehicle use) represent only 5 percent of the total transportation-related Duke University emissions inventory, or about 1 percent of overall emissions, these vehicles represent the most visible statement of Duke's transportation sustainability intentions. As such, it is critically important to advance a greening of this fleet, take advantage of whatever emissions gains are practical, and capitalize on the promotional and educational value of leading by example. The following exhibit presents the "Business as Usual" outlook on fleet related GHG emissions.

Exhibit 30 Business as Usual Fleet related GHG Emissions

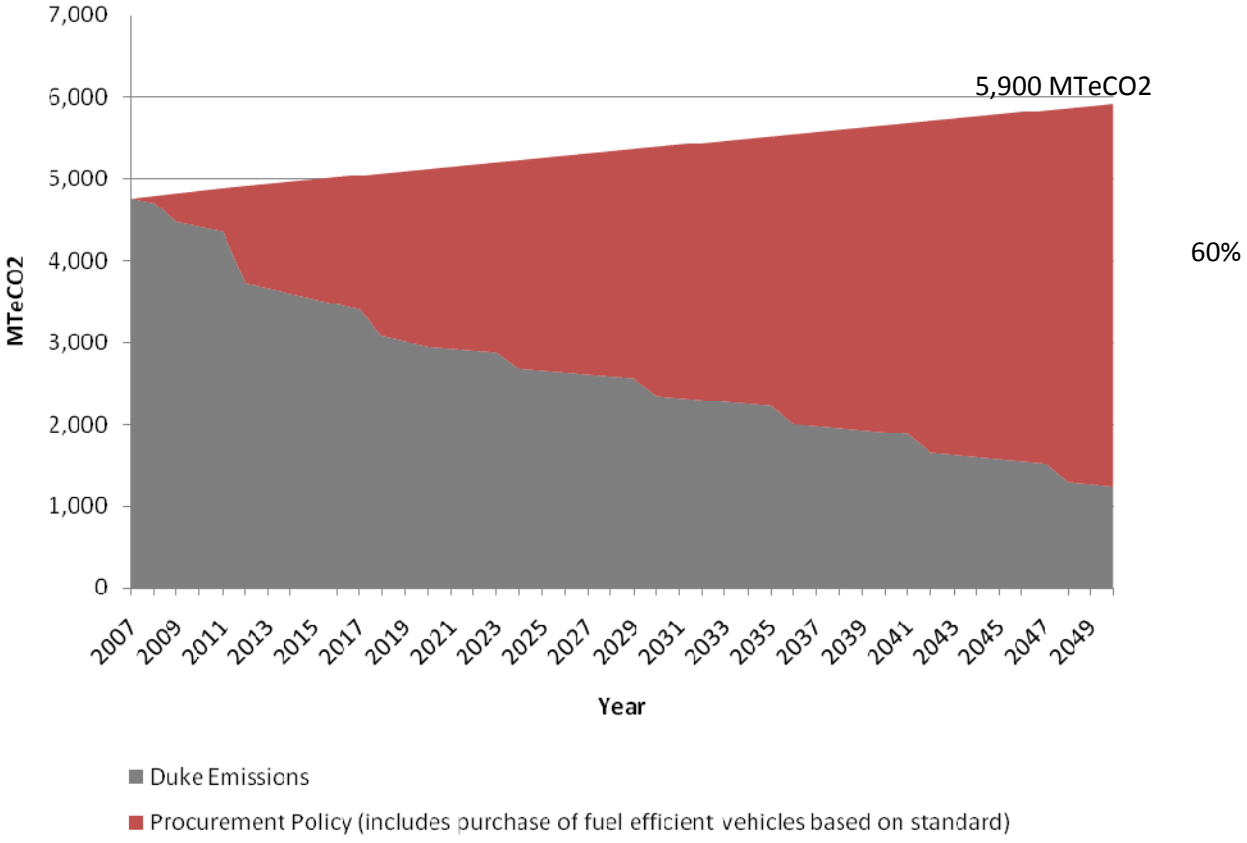


Duke will continue to update its fleet. As replacement vehicles are needed, a procurement policy will ensure that older vehicles will be replaced by more efficient vehicles. The following are fleet efficiency reduction improvements and emissions reduction technology assumed to be implemented as part of this analysis.

- Transit Fleet
  - Assumes replacement and right-sizing of Duke's bus fleet
    - 10 buses within first 5 years
    - 10 additional buses by year 10
    - 10 buses every 5 years after year 2020
  - Procurement policy to achieve 50% emissions reductions (factoring fuel efficiency gains)
- Transit Efficiency Gains
  - Elimination of hospital parking shuttles
  - Assumes more reliance/utilization of DATA and TTA services (in conjunction with park and ride program)
- Fleet Replacement
  - Assumes current replacement schedule of 150 vehicles every 5 years
  - Procurement policy to achieve vehicle efficiency/emissions improvements

Exhibit 31 presents the reduction programs, infrastructure improvements, and emissions reduction technology and their respective of fleet related emission reductions. The overall reduction percentage for each component is provided in the right margin.

Exhibit 31 Total Duke Fleet Related GHG Emission Reductions



Financial Analysis

The following section provides the Duke related costs or savings/revenue generated by each reduction program, infrastructure improvement, and emissions reduction technology. Additionally, metric ton of eCO2 reductions is provided for each reduction component. An efficiency value of dollars over metric ton of GHG emission reduced is calculated to compare the cost effectiveness of each component. Percentage reductions, by transportation component, total transportation, and overall Duke emissions are provided.

Exhibit 32 Commuter Emission Reduction Program Cost Effectiveness

	Duke Incremental Annual Cost $	GHG Reductions MTeCO2	$/MTeCO2	Reduction % Percent of Commuter %	Percent of All Transport %	Percent of Total Duke Emissions %
Commuter Related						
TDM Programming	$(120,000)	2,012	$(60)	3.8%	2.0%	0.48%
Transportation Coordinator	$(62,500)					
Program Budget	$(57,500)					
1 Additional Transit Subsidy	$584,880	293	$1,996	0.6%	0.3%	0.07%
2 Carpool Incentive	$(23,080)	790	$(29)	1.5%	0.8%	0.19%
3 Parking Pricing Increases	*$3,379,150	1,157	$2,920	2.2%	1.1%	0.28%
4 Park and Ride	$2,145,140	1,060	$2,024	2.0%	1.1%	0.25%
5 Inter-city Bicycle Connections	$219,530	233	$942	0.4%	0.2%	0.06%
6 Affiliated Housing (1,500 units)	$2,628,000	2,625	$1,001	5.0%	2.6%	0.63%
7 Improved Transit Service	$420,350	1,060	$397	2.0%	1.1%	0.25%
8 Light Rail/BRT	$1,261,040	2,080	$606	4.0%	2.1%	0.50%
Commuter Vehicle Efficiency (Near-Term)	$ -	20,998	$ -	40.0%	20.9%	5.04%
Commuter Vehicle Efficiency (Long-Term)	$ -	10,499	$ -	20.0%	10.4%	2.52%
		42,807		81.5%	42.5%	10.27%

( ) University Costs, savings are positive
- No Duke cost associated with program
* Estimated net revenue at year 2027 with full implementation of pricing increases

1 Program cost assumes existing transit pass cost of $32/month ($24 cost to rider + current $8 Duke subsidy)
Lost parking revenue assumes average annual cost of $312/year/permit
O&M and debt service savings uses value of $2,400/space (amortized capital cost + O&M)

2 Program cost assumes $200 annual payout for each carpooler
Lost parking revenue assumes average annual cost of $312/year/permit
O&M and debt service savings uses value of $2,400/space (amortized capital cost + O&M)

3 Revenue gain assumes 100% increase in average annual parking costs
Additional carpool incentive assumes $200 annual payout for each new carpooler
Additional transit passes assumes cost of existing transit pass =$32/month ($24 cost to rider + current $8 Duke subsidy)
Lost parking revenue assumes average annual cost of $312/year/permit
O&M and debt service savings uses value of $2,400/space (amortized capital cost + O&M)

4 Assumes leased parking space cost of $50/space (3 lots)
Assumes surface lot constructed on Duke owned land (1 lot) ($4,000/surface space capital cost amortized over 10 years at 5.5%)
Provide transit passes for all park and ride participants ($32/month/person)
O&M and debt service savings uses value of $2,400/space (amortized capital cost + O&M)

5 Capital cost includes 50% subsidy of $100,000 total capital project cost and additional supporting facilities (bicycle racks)
Lost parking revenue assumes average annual cost of $312/year/permit
O&M and debt service savings uses value of $2,400/space (amortized capital cost + O&M)

6 Assumes shift of 1,500 SOV commuters to residents
Assumes $100,000 capital cost/commuter + land cost of $100,000
Assumes no parking for residents

Assumes rent of $700/unit/month
Lost parking revenue assumes average annual cost of $312/year/permit
O&M and debt service savings uses value of $2,400/space (amortized capital cost + O&M)

7 Program cost assumes existing transit pass cost of $32/month ($24 cost to rider + current $8 Duke subsidy)
Lost parking revenue assumes average annual cost of $312/year/permit
O&M and debt service savings uses value of $2,400/space (amortized capital cost + O&M)

8 Program cost assumes existing transit pass cost of $32/month ($24 cost to rider + current $8 Duke subsidy)
Lost parking revenue assumes average annual cost of $312/year/permit
O&M and debt service savings uses value of $2,400/space (amortized capital cost + O&M)

Capital cost amortization interest rate of 5.5%
Amortization of structured parking over 20 years
Amortization of surface parking over 10 years
Amortization of residential building over 20 years

As shown, there are several programs that would likely save Duke money when implemented. The most cost effective program as it relates to elimination of GHG emissions is an increase in parking price.

Exhibit 33 Air Travel Emission Reduction Program Cost Effectiveness

	Duke Incremental Annual Cost $	GHG Reductions MTeCO2	$/MTeCO2	Reduction % Percent of Air Travel %	Percent of All Transport %	Percent of Total Duke Emissions %
Air Travel Related						
Air Travel Policy/Guidance	$ -	4,340	$ -	10%	4.3%	1.04%
Air Craft Fuel Efficiency	$ -	10,849	$ -	25%	10.8%	2.60%
Air Traffic Management Enhancements	$ -	5,208	$ -	12%	5.2%	1.25%
Long Term Aircraft Technology	$ -	6,510	$ -	15%	6.5%	1.56%
		26,906		62.0%	26.7%	6.45%

( ) University Costs, savings are positive
- No Duke cost associated with program

As shown, none of the programs would likely cost Duke money when implemented.

Exhibit 34 Fleet Emission Reduction Program Cost Effectiveness

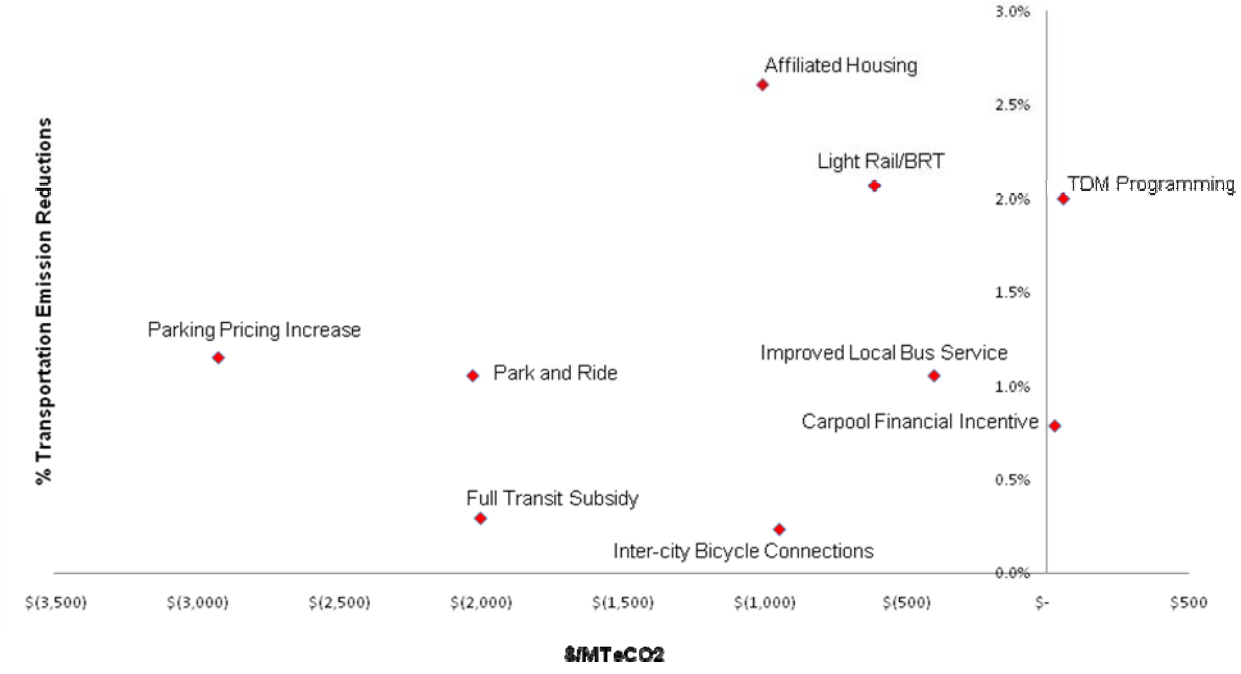
	Duke Incremental Annual Cost $	GHG Reductions MTeCO2	$/MTeCO2	Reduction % Percent of Air Travel %	Percent of All Transport %	Percent of Total Duke Emissions %
Fleet Related						
Fleet Improvements	$ -	2,854	$ -	60%	2.8%	0.68%
		2,854		60%	2.8%	0.68%

( ) University Costs, savings are positive
- No Duke cost associated with program

As shown, there are no incremental annual costs associated with the fleet emission reduction program which would not likely cost Duke money when implemented due to the fact that higher fuel economy vehicles will become the industry standard in the future.

Exhibit 35 plots the cost effectiveness ratio ($/MTCO2e reduced) of each Duke influenced GHG reduction strategy with respect to its transportation related emissions reductions.

Exhibit 35 Cost-Effectiveness of Duke GHG Transportation Strategies



Cumulative Transportation Program Results

The following exhibit presents the Duke influenced GHG reduction strategy and its cost effectiveness ratio ($/MTCO2e reduced) with respect to its transportation related emissions reductions.

Exhibit 36 Duke Influenced Cumulative Reductions

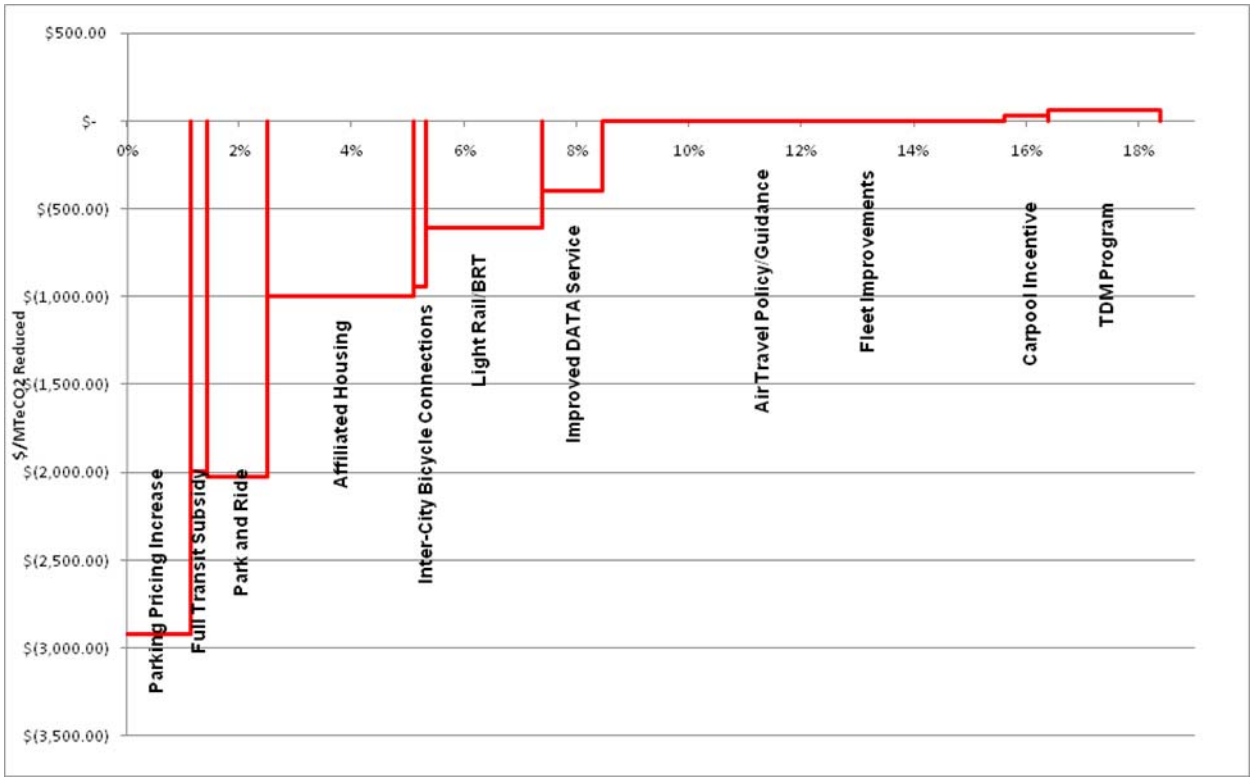
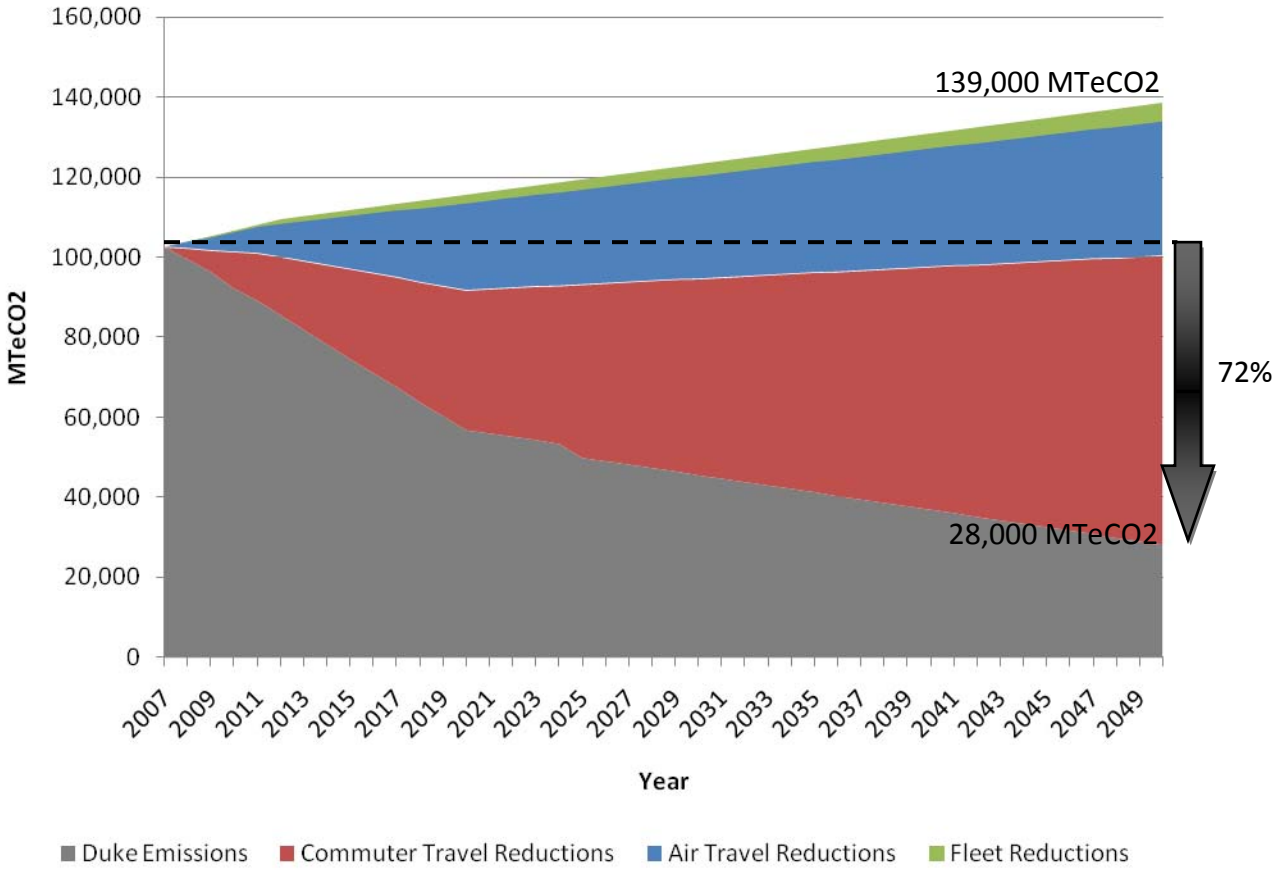


Exhibit 37 presents the overall Duke Transportation-Related GHG emission reductions. As shown, emissions are reduced by 72 percent from existing emissions by year 2050.

Exhibit 37 Duke Transportation-Related GHG Emission Reductions



Annualized Program Implementation Costs

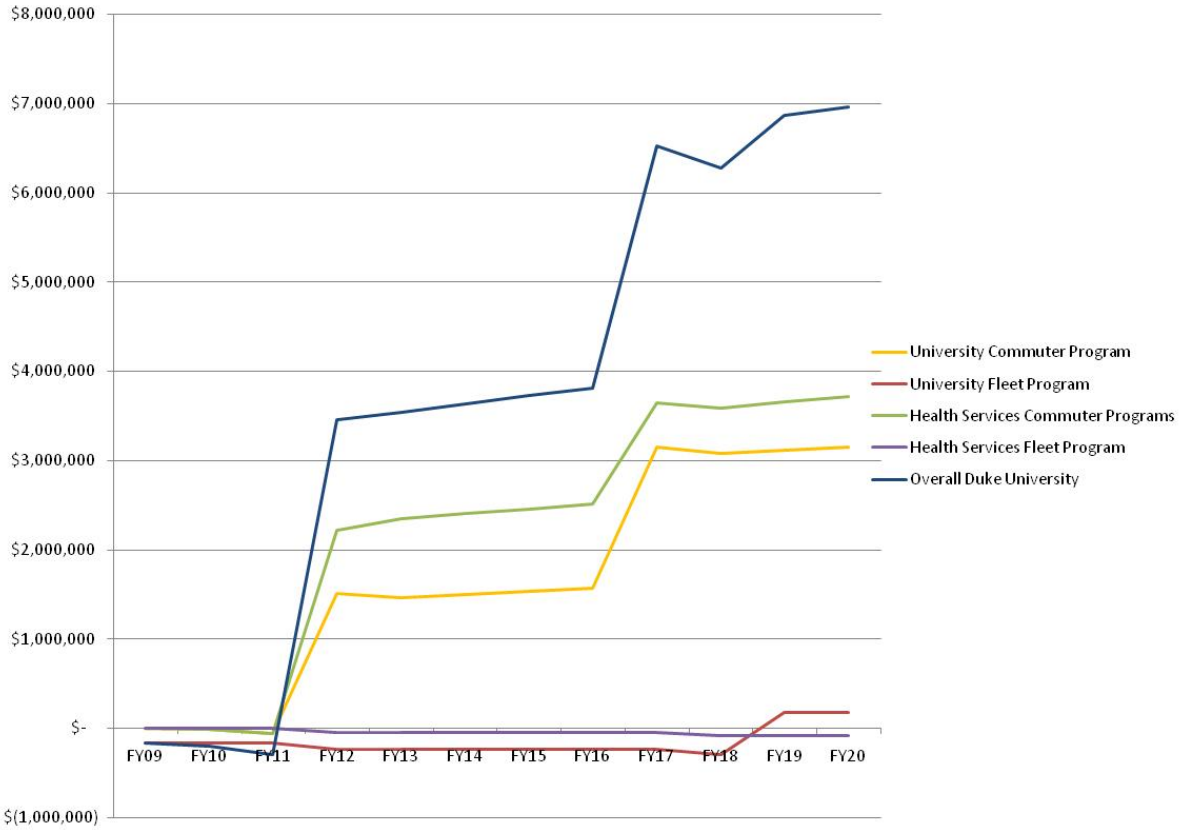
For planning purposes, a financial analysis of implementing the transportation component of the Climate Action Plan (CAP), as outlined in prior sections of this report, represented the last task of this study effort. This cost analysis accounts for the following factors:

- Costs to implement or subsidize the program element;
- Estimated travel demand effect of program (population shift among transport modes or travel demand reduction);
- Parking revenue implications (revenue associated with parking price increases and/or costs associated with parking revenues lost); and,
- Operational and debt service cost savings associated with the reducing the need for parking.

The implementation plan strategies were scheduled over the period between 2009 and 2050. The associated plan costs, revenues, and savings were estimated on an annual basis for the two major entities: Duke University Main Campus and Duke University Health System. (Admittedly, out-year projections beyond 10 to 15 years are highly speculative). A key assumption inherent in this analysis, amongst the many implementation assumptions, and the program financial results is a 100 percent increase in parking rates over time (25 percent in Fiscal Year 2012, 50 percent in Fiscal Year 2017, and 100 percent in Fiscal Year 2022).

The results of the analysis of overall program costs are summarized in Exhibit X below. Detailed spreadsheets are also included in the Appendix.

Exhibit 39 Climate Action Plan Estimated Transportation Program Costs



Our analysis forecasts the need for program subsidies for the first three years ranging from $170,000 to $300,000 per year, After Fiscal Year 2012, when the first parking pricing increase is implemented, the CAP transportation program will have positive cash flows with the increases in parking revenue significantly offsetting commuter and fleet program costs.

Energy

Summary Recommendations

The following are near-term recommendations advanced by the Energy Subcommittee of the CSC to address GHG emissions related to purchased electricity and steam production at Duke:

- Duke should push beyond the current LEED™ building policy to establish green building energy consumption standards and an approval protocol for building energy consumption review. Duke should implement, measure and report on energy use targets by Building Tech Rating

- Duke should implement, beginning in 2010, energy conservation measures (ECMs) in existing buildings with the goal to realize a 15% reduction in energy use over a 20 year period (2010 – 2030)

- Duke should discontinue the use of coal as soon as possible. Duke should complete the gas-fired East Plant steam plant construction and start-up in 2010 and initiate the West Campus steam plant conversion from coal in 2012

- Duke should continue to urge, monitor and review Duke Energy's progress towards emissions reductions while exploring on-campus electricity generation options. Additionally, Duke should install 4MW solar PV array by 2012

- Duke should leverage research into alternative technologies and explore and implement conversion to biogas, solar PV, solar thermal, combined heat and power or other technologies by 2030

- Duke should pursue plant efficiency improvements with tactics such as: distribution system upgrades, thermal storage, chilled water expansion and upgrade, and boiler plant heat recovery

Energy

This section describes the baseline assumptions used in the existing GHG emissions inventory of energy use at Duke; overviews the existing energy use conditions; and presents a wedge analysis of the most viable energy emission reduction measures that Duke University might implement to achieve the goals of its climate neutrality plan.

Background

Energy use at Duke has a significant impact on the environmental footprint of the university and comprises 76 percent of the campus GHG emissions. Direct energy emissions, or the majority of Duke's Scope 1 emissions, stem primarily from combustion of coal to produce steam at the central plant on main campus. Historically, coal has been used to produce over 90 percent of Duke's steam. Natural gas and fuel oil are used for the other 10 percent. Emissions

from the production of steam currently make up 24 percent of Duke's total GHG emissions (including emissions from transportation).

Duke's indirect emissions from purchased electricity, or Scope 2 emissions, currently make up 52 percent of the total campus GHG emissions (including emissions from transportation). The carbon intensity of these emissions will be impacted by Duke Energy's plans to reduce their GHG emissions over time as discussed in the following section.

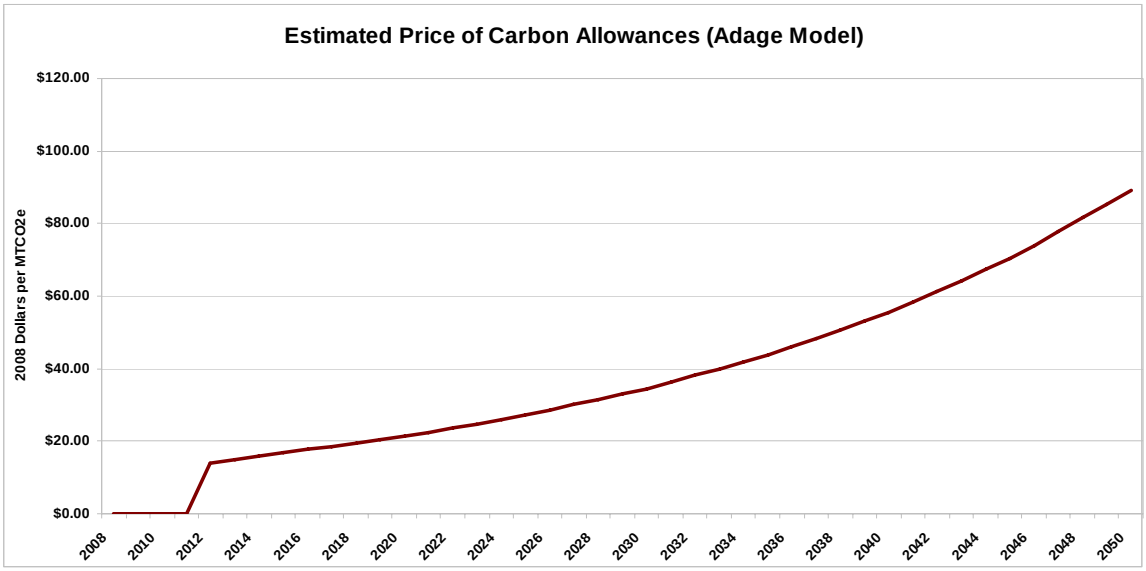
Assumptions for Energy Emission Analysis

Effects of Carbon Legislation

One of the major assumptions in developing this climate action plan was that some form of carbon legislation would be instituted at the federal level in the near future. Such legislation will have significant financial impact on all entities that emit greenhouse gases (GHGs), whether those entities plan to reduce those emissions or not. In other words, there will be a cost associated with "doing nothing." These scenarios, that place a value on every ton of carbon dioxide equivalents (CO_2e) emitted, create value for projects that reduce GHG emissions.

There are several potential proposals currently under consideration for how to regulate carbon emissions. Each proposal has modeled the result of carbon regulation on the price of carbon and correspondingly on the price of fuels (based on both the carbon content of various fuels and the effects of supply and demand changes associated with the proposed legislation). For this analysis, the University chose to use modeling results developed by Duke's Nicholas Institute for Environmental Policy Solutions and the Climate Change Policy Partnership (CCPP). These two entities modeled carbon and energy prices using the Adage model. It is also assumed that carbon legislation will be in place by year 2012.

Carbon Allowance Price Projections



As a regulated entity, Duke Energy (Duke University's purchased electricity provider) will also have to comply with any greenhouse gas emission regulations that may be instituted. As such, the carbon content of the electricity Duke University purchases from Duke Energy is expected to decline over time. Duke Energy has provided projections of their future greenhouse gas emissions (in terms of $MTCO_2e$ per MWh) through 2050. A portion of these projections is based on near-term plans for compliance with North Carolina's Renewables Portfolio Standards (RPS) which requires the use of renewable energy sources for 12.5 percent of electric power generation by 2021 for investor-owned utilities.

Duke Energy is also planning to develop two new nuclear plants that will generate large amounts of carbon-free electricity and thereby reduce their greenhouse gas emissions significantly. It should be noted that Duke University acknowledges the problematic issues with nuclear power that have yet to be addressed such as waste disposal. In the longer term (2029 to 2050), Duke Energy has modeled their greenhouse gas emissions according to the national reduction goals associated with the U.S. Climate Action Partnership. Figure 1 displays Duke Energy's projected CO_2 emission factors.

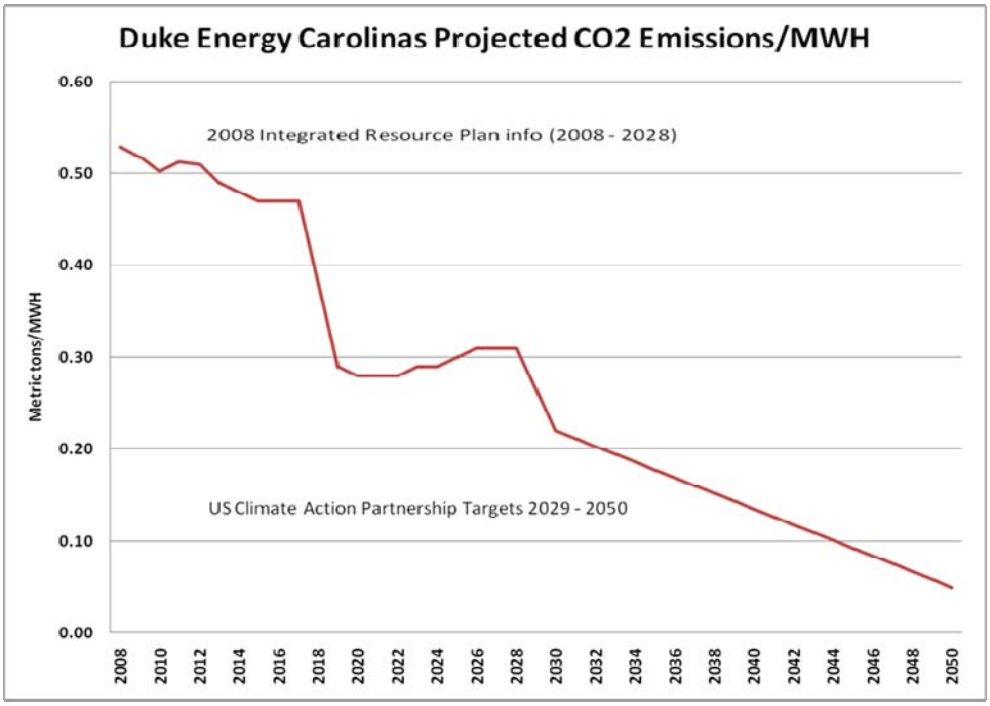


Figure 1. Duke Energy Projected CO_2 Emissions

Campus Growth

In developing a plan for greenhouse gas emissions reductions, Duke first had to estimate how GHG emissions would grow unmitigated into the future. Since the primary driver for energy

use on campus is the total building footprint, this metric was used to project future energy use. The assumptions for campus growth are summarized in Table 1. These assumptions are based on short-term known University and Health System building projects such as the Cancer Center Addition, Major Hospital Addition, and the Indoor Practice Facility. Long-term future growth is estimated based on historical patterns and the expectation that current economic conditions will slow the pace of campus construction significantly.

Table 1. Projected Campus Building

	2008 – 2013 Growth (GSF per year)	2014 – 2050 Growth (GSF per year)
University & School of Medicine	27,000	50,000
Health System	169,000	50,000
Total	196,000	100,000

These total square footage additions will be made up of various types of buildings. For the purposes of these projections, the following mix of buildings was assumed (see Table 2). These percentages are based on the current campus breakdown of building type and expected future growth in particular areas.

Table 2. Makeup of Future Construction (as percent of total future building)

	Laboratory	Housing	Office/Classroom
University & School of Medicine	58%	8%	34%
Health System	75%	0%	25%
Total (weighted average)	68%	3.5%	28.5%

Using the current average energy use intensity factors for various building classifications at Duke, the future "business as usual" energy use and associated greenhouse emissions associated with the growth of Duke's campus through 2050 was estimated. The average energy use intensities are shown in Table 3.

Table 3. Average Energy Use Intensities of Existing Buildings

	Laboratory (Tech 5) (kBtu/GSF)	Housing (Tech 3) (kBtu/GSF)	Office/Classroom (Tech 3) (kBtu/GSF)
Current Average EUI	300	162	162

Note the existing building stock is divided into "Tech Rating" categories based on the complexity of building systems. Laboratories are considered "Tech 5" buildings or the most energy intensive, while offices, classrooms, and housing are considered "Tech 3" buildings. The

average energy use intensities were calculated based on these previous groupings as shown in Figure 2.

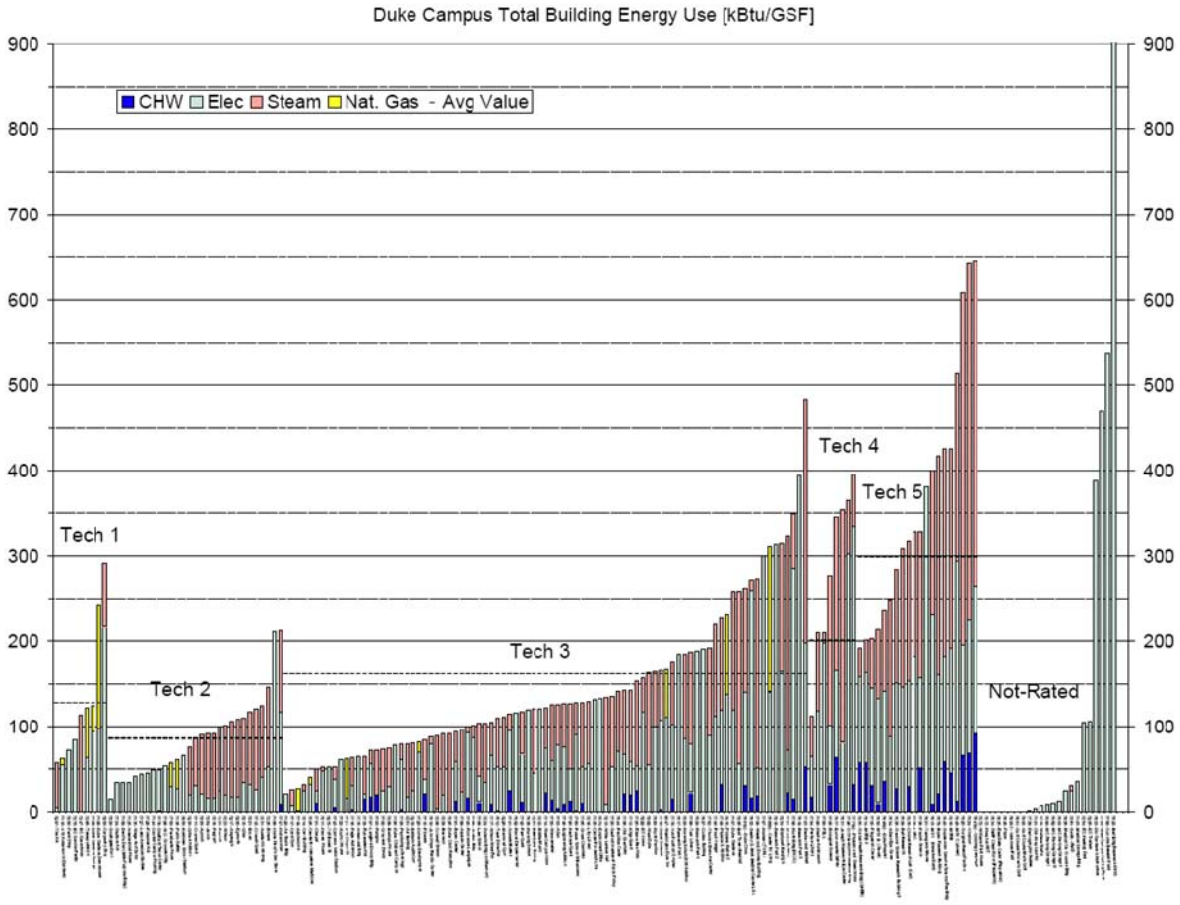


Figure 2. Energy Use Intensity Analysis of Existing Buildings by Tech Rating

These estimates of future building and future building energy use, combined with the unmitigated energy use and associated emissions from existing buildings represent Duke's projected future energy-related GHG emission footprint as shown in Figure 3. The total "business as usual" emissions from the production of steam and purchased electricity for the university, school of medicine, and hospital combined are projected to rise, if unmitigated, from about 350,000 $MTCO_2e$ in 2007 to about 528,000 $MTCO_2e$ in 2050. These projections do not include emissions from transportation, nor do they include GHG emission reductions from Duke Energy. Duke Energy reductions were modeled separately to emphasize their potential impact on Duke's footprint.

Projected Business as Usual GHG Emissions

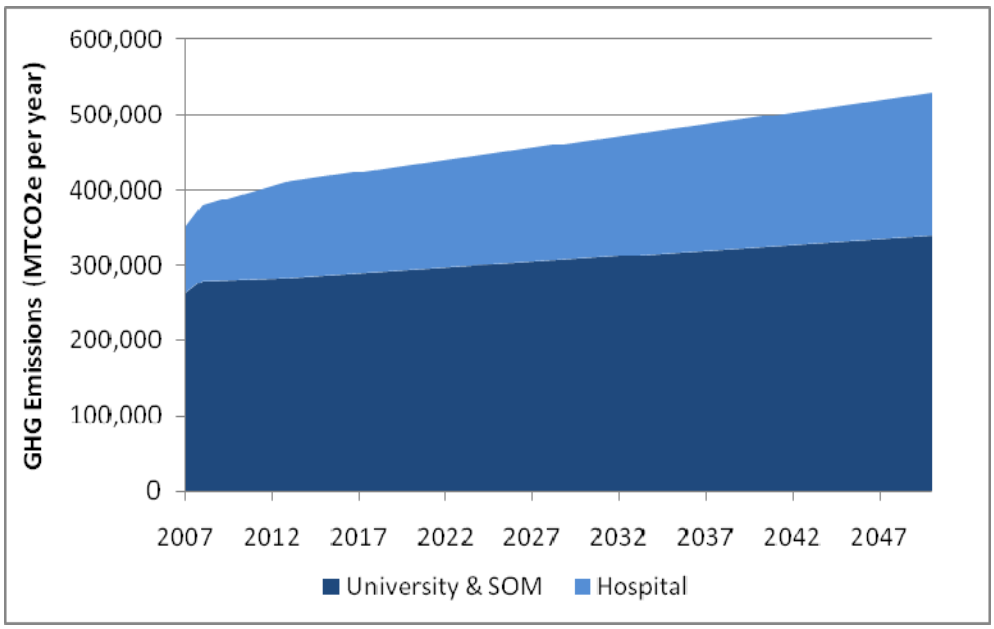


Figure 3. Projected Business as Usual GHG Emissions from Energy

Wedge by Wedge Analysis

In order to better understand opportunities for reducing energy emissions at Duke, a wedge analysis has been employed. This provides a visual representation of greenhouse gas reductions due to program implementation or events over time. Potential reduction measures were evaluated using this wedge analysis to understand the long-term benefits of each program and to estimate the long-term GHG reductions. The wedges explored include:

- Purchased electricity
- Green building
- Energy conservation in existing buildings
- On-site renewable energy
- Fuel mix

Purchased Electricity

As discussed previously, the university's electricity provider, Duke Energy, is planning significant changes to their infrastructure over the next 40 years to comply with state laws and in anticipation of federal carbon legislation. Although Duke Energy's reductions are largely outside of the control of Duke University, they have been modeled as the first "wedge" in the University's GHG reduction graph to display the potential impact Duke Energy could have on the University's GHG emission footprint.

Green Building

In the base case, it was assumed that future buildings would be built to current average energy

use intensities. However, Duke has committed to constructing new buildings to higher standards set forth by organizations such as the U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) Green Building Rating System. As of June 2009, Duke has twenty three buildings that are either LEED certified or seeking certification. The buildings that have already received certification achieved an average of 2, out of a possible 10, energy points (LEED v2.2 EaCr1).

For this analysis, it was assumed that Duke will target even more aggressive green building goals by designing new buildings to achieve 4 energy points (LEED v2.2 EaCr1). These future buildings will consume less energy than Duke's existing buildings and will therefore lower the unmitigated future emissions shown in Figure 2.

Based on the advice of experts in the design and energy modeling for LEED certified buildings, Duke has developed targets for energy use in buildings designed to the "LEED+" targets the university is pursuing. Duke's actual and target energy use intensities are summarized in Table 4.

Table 4.Energy Use Intensities (EUI) for Duke Buildings with LEED+ Targets

	Office/Classroom (Tech 3)	Housing (Tech 3)	Laboratory (Tech 5)	Weighted Average
Annual Growth (% of GSF)	28.5%	3.5%	68%	
2008 Duke Actual Average EUI – all buildings (kBtu/GSF)	162		300	212
Duke LEED Buildings Average	132		249	177
National LEED Average (kBtu/GSF)	85	100	260	175
National ASHRAE 90.1 (kBtu/GSF)	100	120	300	203
Recommended Target LEED+ EUI	**65**	**80**	**250**	**160**

This comparison shows how Duke's LEED and non-LEED buildings compare to two metrics, an "average" LEED building in the US and an standard ASHRAE 90.1 designed building in the US., on a kBtu/GSF basis. While Duke's laboratory buildings successfully score at or below the national averages, the less complex, Tech 3 buildings, are much more energy intensive than the even the ASHRAE 90.1 buildings. To ensure Duke's future buildings are less energy intensive, it

is recommended that projects strive to meet or exceed the EUI targets highlighted in the table above with a weighted average EUI target of 160 kBtu/GSF.

Energy Conservation in Existing Buildings

Duke's existing stock of buildings also represents an opportunity for energy use reductions through conservation efforts. Although Duke has already implemented many energy conservation measures (ECMs) to achieve significant energy reductions, it is estimated an additional 15 percent reduction in energy use in existing buildings could be achieved by implementing additional ECMs such as the following by 2030:

- Building scheduling and operating hours
- Housekeeping hours and midnight walkthroughs
- Retro-commissioning to retune buildings
- Addition of Solar Thermal for water heating
- Plug load management
- Campus site lighting
- Motion switches and other lighting controls
- Energy management system expansion and optimization
- LED lighting retrofits in select areas
- Variable Air Volume (VAV) fume hoods
- Demand or occupied/unoccupied ventilation rate reduction
- Hot water system temperature reset
- Air Handling Unit (AHU) supply air static pressure reset
- Steam distribution system improvements

The specific ECMs to be included in this program will be studied and identified as part of a separate project. It is assumed, however, that these more aggressive ECMs will likely require more capital than the ECMs already implemented to capture the "low-hanging fruit" of energy savings. Based on Duke's current ~$40 million annual expenditures on energy and assuming a 7.5-year payback, the total capital required for these ECMs is estimated at $45 million. Assuming the ECMs are implemented and paid for over 20 years, Duke would need to spend $2.25 million per year for 20 years to achieve this 15 percent overall reduction in existing buildings (i.e., buildings that existed as of 2009) by 2030.

On-site Renewable Energy

For the purposes of this initial version of Duke's Climate Action Plan, only one source of on-site renewable energy was modeled as a potential alternative – producing electricity using a solar photovoltaic (PV) arrays. By placing these PV arrays atop three existing parking garages and the Smith Warehouse Building, Duke estimates it can install up to 4MW of nominal electrical production capacity at a cost of about $12 million (50 percent of total installed cost assuming

Duke could take advantage of solar tax credits). At an average 20 percent utilization factor, these solar PV arrays could produce up to about 7 million kWh per year – or about 1.5 percent of Duke's annual electricity usage. It is assumed this electrical output would be connected to Duke Energy's grid, but Duke University would be able to maintain the carbon credits.

Assuming a 2012 start date, the purchased electricity avoided by this project would equate to about 3,500 $MTCO_2e$ per year. However, as Duke Energy lowers its GHG emissions as described in Section III.a., the GHG reduction associated with the solar PV would also decrease – to an estimated 350 $MTCO_2e$ per year in 2050.

Fuel Mix

As described previously, Duke's existing West steam plant produces all of the steam required by the campus using coal as the primary fuel. There are also two electric-driven chilled water plants. Currently under construction is a natural gas fired steam plant (East Plant) that will utilize fifteen Miura package boilers to produce steam. The new East Plant is expected to reduce Duke's GHG emissions associated by over 45,000 $MTCO_2e$ per year by allowing the university to switch from coal-based steam production to natural gas-based steam production. Some coal combustion will still be required during winter months to provide baseloaded steam production, but overall coal combustion may be cut by as much as 85 percent.

In the near future, as early as 2012, Duke may also convert the existing West Plant to natural gas in order to cease combustion of coal altogether. Although the bulk of the coal used by Duke will be alleviated by the new East Plant, converting the West Plant would remove an additional 8,000 $MTCO_2e$ per year from Duke's GHG emission footprint. The capital costs, related to the Climate Action Plan, to convert the West Plant to burn natural gas and install a high pressure gas line to serve the plant is estimated at $10 million.

Further in the future, Duke may convert both plants to utilize biogas from a renewable resource. Although the source of this biogas is not determined, it could potentially be generated from a number of sources, including biomass gasification for example. For the purposes of this study, it was assumed that the biogas would come from an herbaceous resource like woody waste. Although woody biomass is considered a renewable resource and carbon dioxide emissions associated with its use as a fuel are not counted as part of Duke's GHG emissions, we have included a small amount of GHG emissions from the methane (CH_4) and nitrous oxide (N_2O) released during the gasification/combustion of biomass. These chemicals are not part of the short-term carbon cycle that allows us to discount the CO_2 emissions. For reference, it is estimated that GHG emissions from biomass are 0.00014 $MTCO_2e$/mmBtu[14]. To compare with other fuels, GHG emissions from natural gas are 0.053 $MTCO_2e$/mmBtu and coal is 0.094 $MTCO_2e$/mmBtu.

[14] 2006 IPCC Guidelines, p. 2.21

GHG Emissions Factors of Potential Fuel

Coal	0.094
Fuel Oil	0.072
Natural Gas	0.053
Biogas	0.00014
Electricity (2010)	0.146*
Electricity (2035)	0.053*
Electricity (2050)	0.015*

*Emission factors based on projected future estimates from Duke Energy.

Additional fuel mix options were considered during the development of Duke's Climate Action Plan. Biomass options in the existing West Campus Steam Plant were evaluated and found to be impractical due to its location on campus and the increased volume of truck traffic that would be required for a biomass fuel. Duke is still considering smaller biomass projects, such as a wood chip fired boiler located adjacent to Chilled Water Plant 2. Such a plant, combined with the conversion of a portion of the West Plant to gas, would allow Duke to eliminate the use of coal. Further study is required into the availability and dependability of wood chips as a fuel source as well as potential value of the Renewable Energy Credits to determine its long-term viability.

Another option focused on the use of combined heat and power (CHP) systems that would burn natural gas to produce both steam and electricity for the university. A 9 MW CHP system was analyzed that, along with the East Plant, would provide enough steam to satisfy the year-round base load requirements of the university. Peak load steam demands would be provided by the West Plant using natural gas. The second CHP system considered was a 42 MW system that, by itself, would produce enough steam to satisfy the annual base load demand.

These CHP systems are not included in the CAP at this time for two primary reasons. First, based on preliminary high-level analysis, the options were not financially competitive with the options to convert existing systems to natural gas – particularly considering the new East Plant is already under construction. Second, given Duke Energy's plans to reduce their GHG emissions from electricity production and thereby the emissions attributed to Duke University's purchased electricity, there will likely be a point in time when it becomes counter-productive for the university to produce electricity using natural gas – even with the added efficiency of combined heat and power production. If Duke Energy meets their emission targets, they will be able to produce electricity at a lower carbon intensity than a Duke CHP plant. These assumptions are largely dependent upon Duke Energy accomplishing the GHG emission reductions they have forecasted and their progress will be monitored to inform future evaluations of CHP's viability at Duke University.

Recommended Energy Mitigation Strategy

Reduction Potential

To show the cumulative effect of the GHG reductions from each analyzed wedge, Duke has layered the analyses and calculations into GHG emission reduction graphs that show the projected business as usual growth of GHG emissions over time (through 2050) and the potential emission reductions associated with the recommendations from each wedge (see Figure 4).

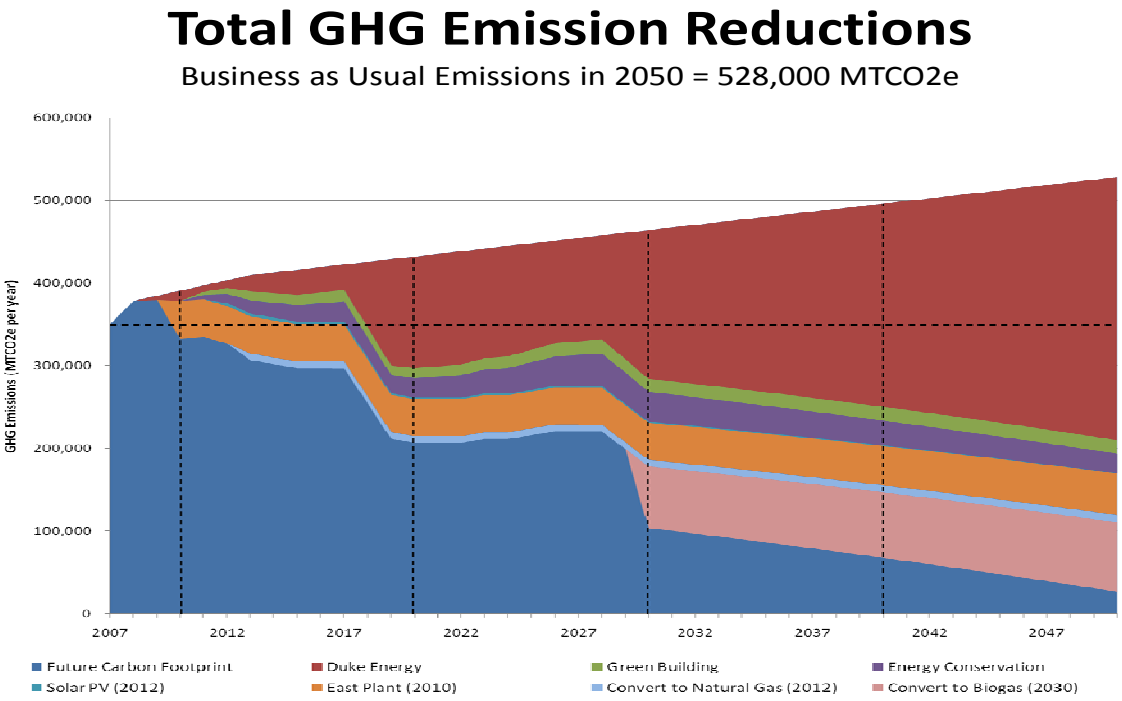


Figure 4. GHG Emission Reductions by Wedge Through 2050

The first wedge is associated with Duke Energy's planned GHG emission reductions and the effect they will have on the university's future emissions based on business as usual growth projections. The next two wedges are the demand-side reductions associated with Green Building (in green) and Energy Conservation (in purple). The actions recommended by these wedges affect the energy demand of the university relative to the business as usual case and create a new reference case for subsequent wedges. The impact of these wedges is also affected by the Duke Energy wedge. For example, Green Building and Energy Conservation efforts will reduce the future use of electricity by the university, but the impact on GHG emissions from those reductions in electricity demand is lessened by the fact that Duke Energy will reduce the GHG footprint of the electricity. Note this is why these wedges narrow over time as their impact lessens.

The supply-side wedges are layered in next, starting with Solar PV (in dark blue). As discussed previously, the impact of this option is small and will diminish over time as Duke Energy reduces

GHG emissions from the purchased electricity that Solar PV will offset. The impact of the East Plant (shown in orange) is significant as Duke shifts the majority of its steam production from coal to natural gas. The complete conversion of the remaining coal to natural gas is shown next (in light blue). Finally, the conversion of all steam production to biogas in 2030 is shown in pink. Figure 5 displays the relative impact of all the wedges as a percentage of Duke's projected business as usual emissions in 2050, assuming offsets will be purchased to reduce Duke's GHG net emissions from energy to zero.

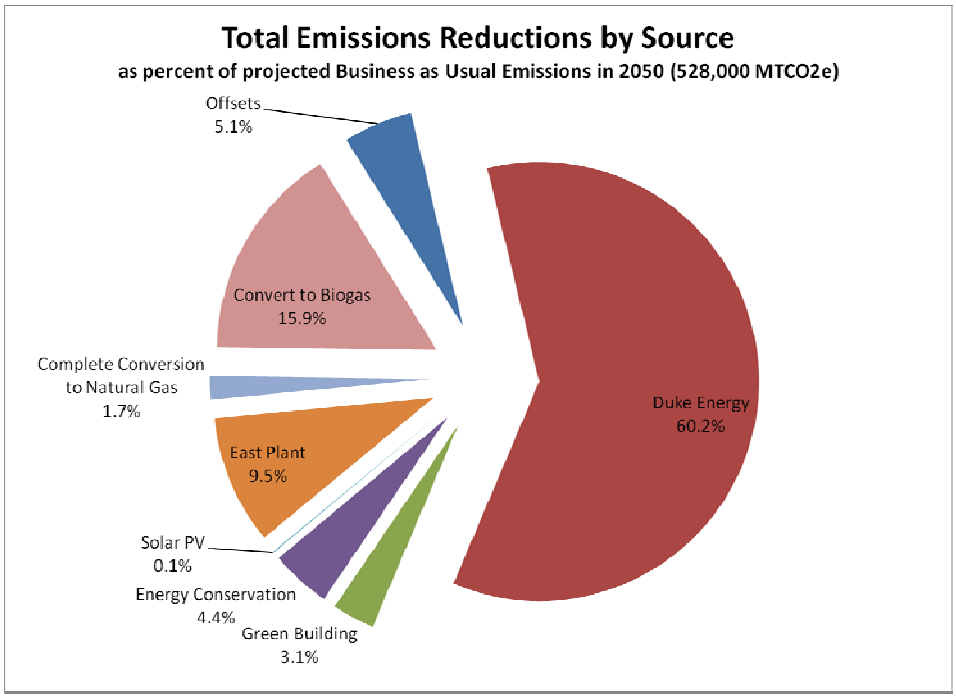


Figure 5. 2050 GHG Emission Reductions by Wedge

Figures 6 through 9 display the same wedge graphs as shown above, except they illustrate the University and School of Medicine (SOM) separately from the Health System. Each graph also shows the projected business as usual emissions for each segment. The impact of demand side wedges is applied to the University & SOM and the Health System by the forecasted growth of new building (for the Green Building wedge) and the relative percentage of existing square footage (for Energy Conservation). The impact of the supply-side wedges is split based on historical use of steam and electricity at the University & SOM and the Health System, respectively. Note that the Solar PV wedge is only applicable to the University & SOM.

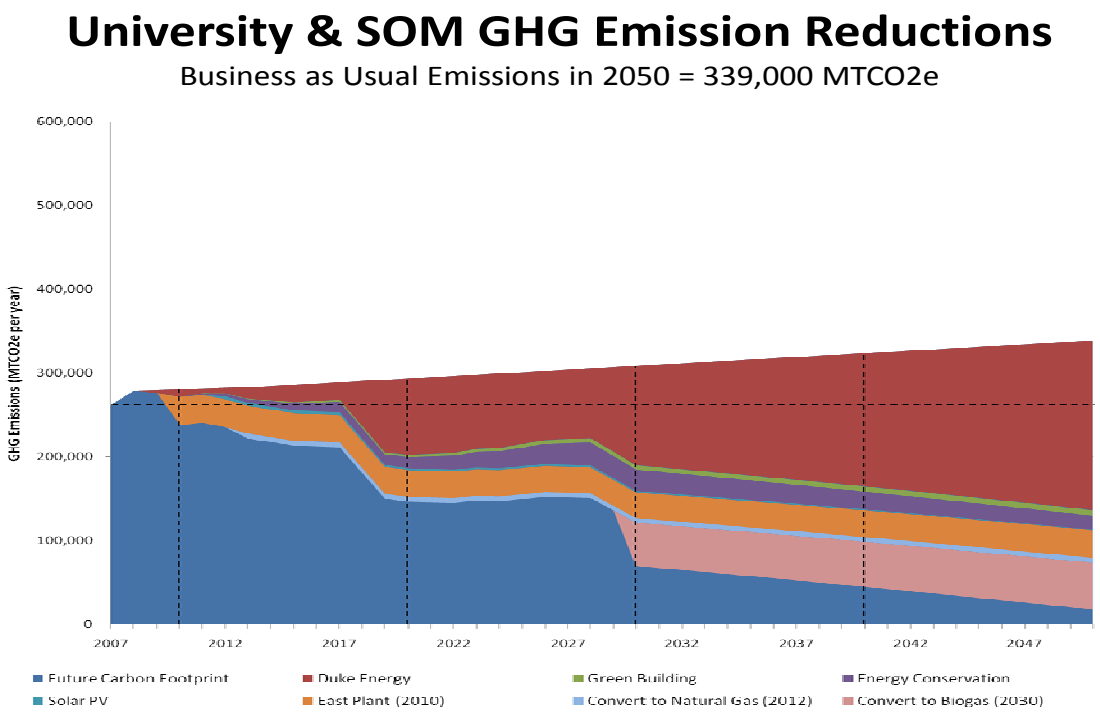


Figure 6. GHG Emission Reductions for the University & SOM

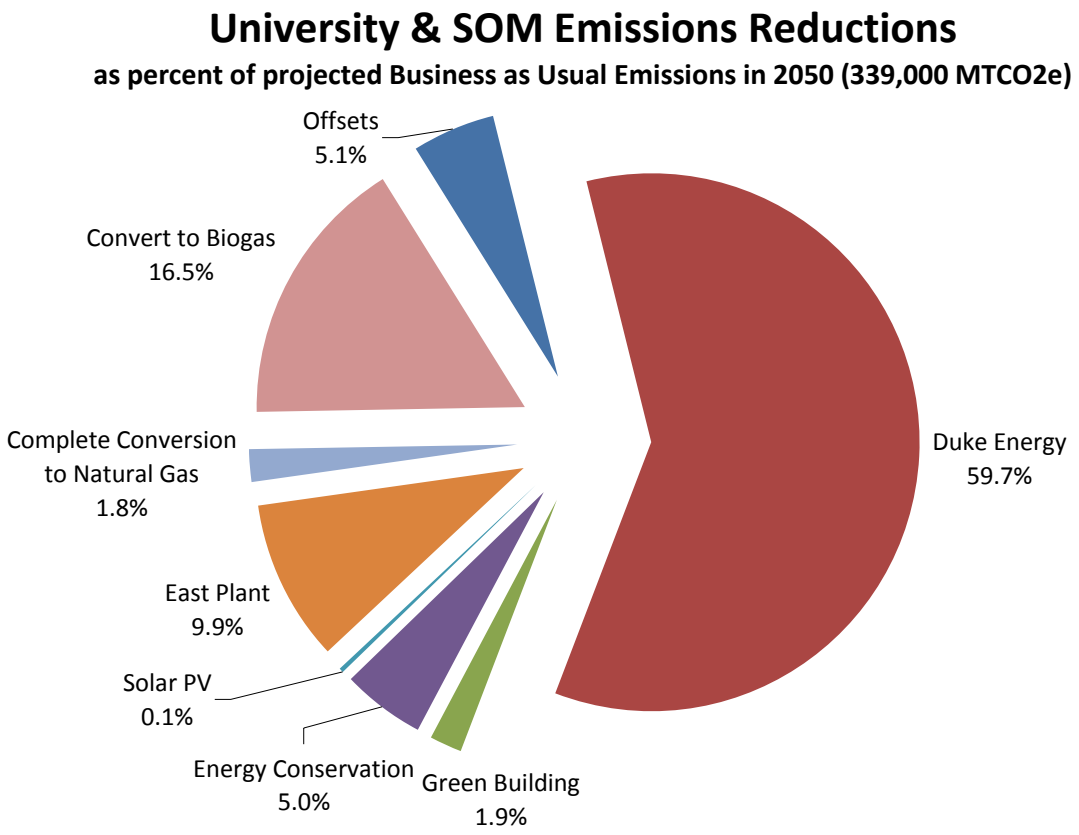


Figure 7. 2050 Emission Reductions by Wedge – University & SOM

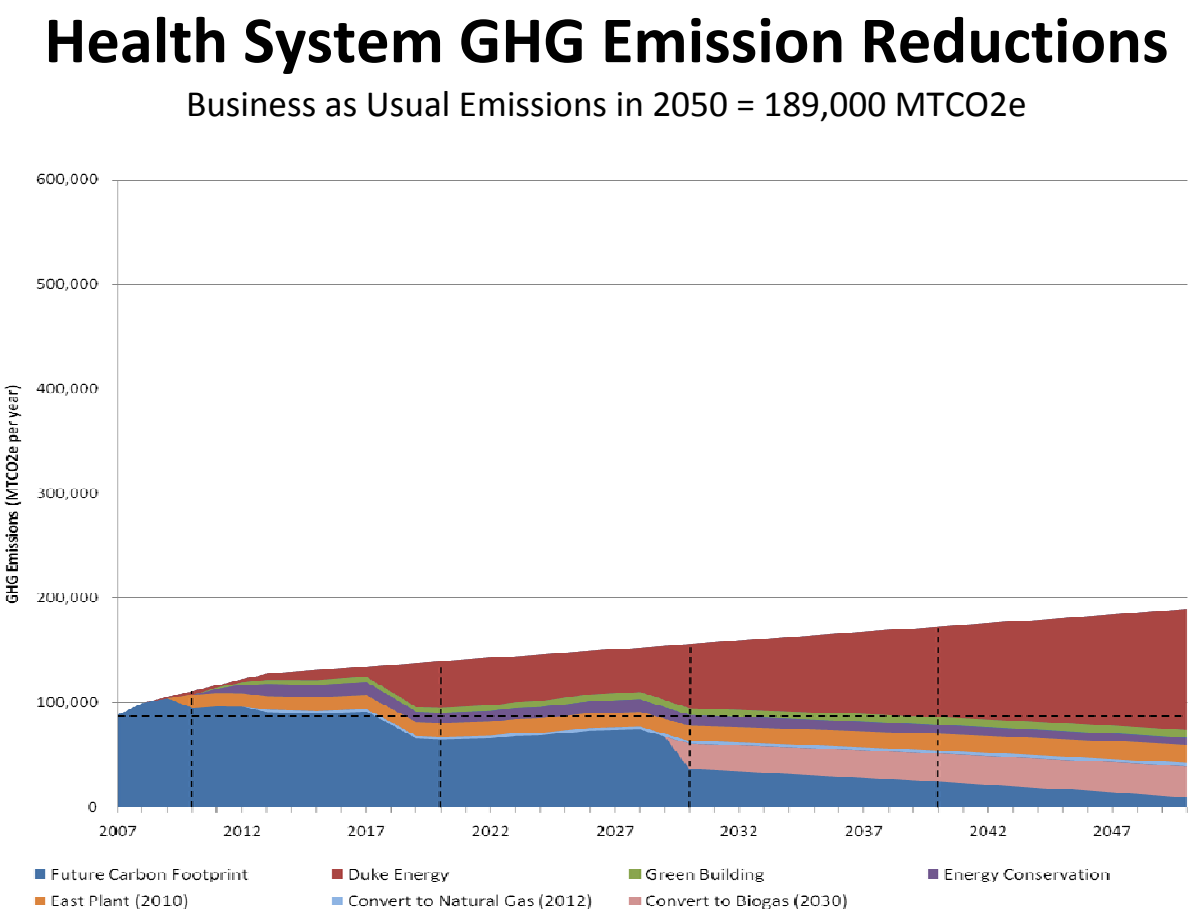


Figure 8. GHG Emission Reductions for the Health System

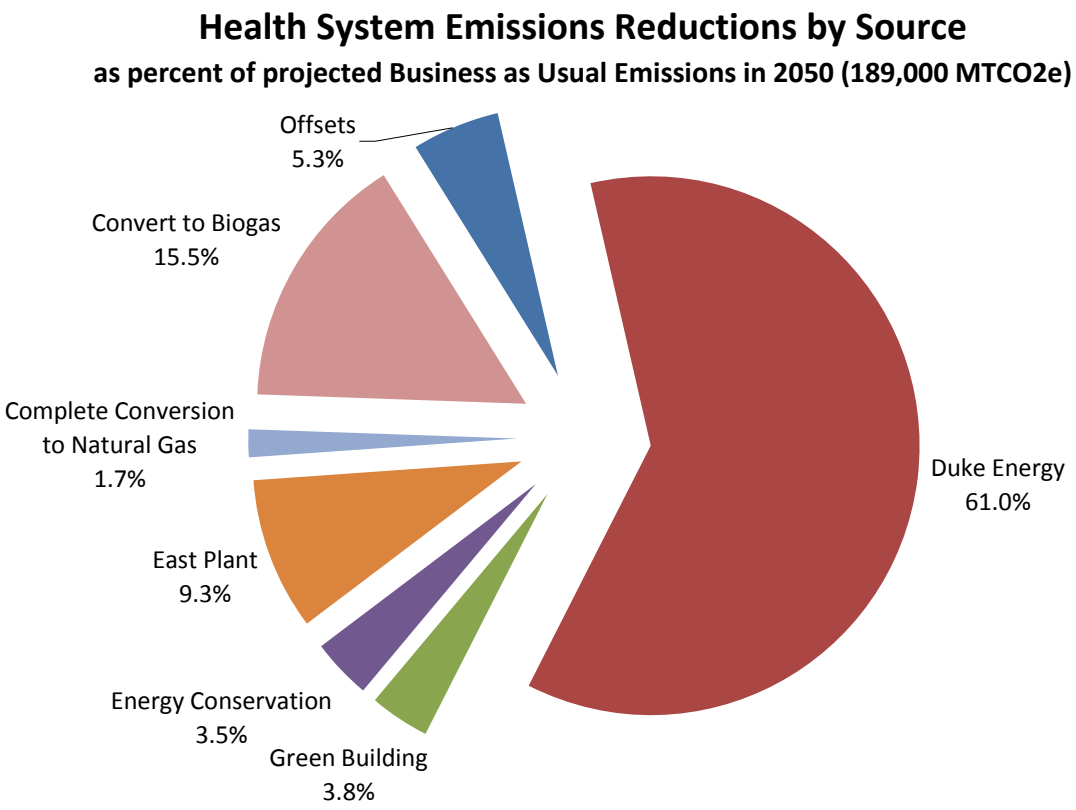


Figure 9. 2050 Emission Reductions by Wedge – Health System

Financial Analysis

Duke has developed a model of the cash flow required to achieve the recommendations presented here between 2009 and 2050. The model includes the total capital for each wedge/option, debt service on that capital, energy savings (or costs), changes in maintenance costs, and the projected value of the carbon abated by each option.

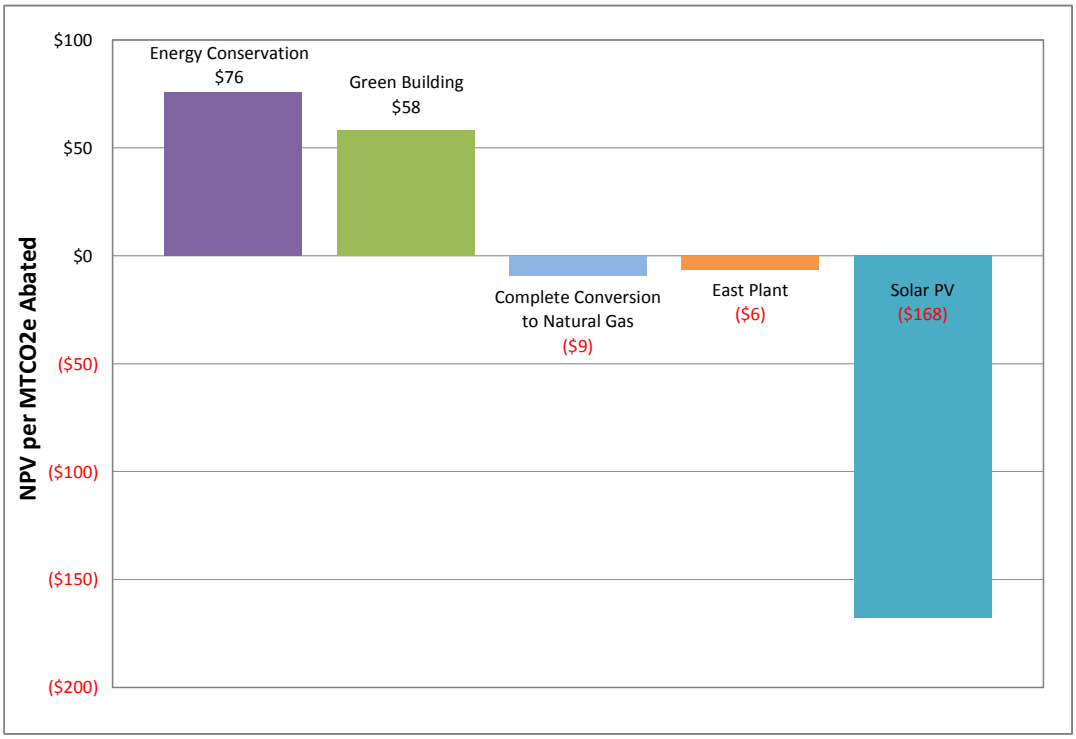
Capital costs are based on rough engineering estimates for each option. More detailed analysis the options chosen will be required to make investment-ready decisions. The current model includes capital estimates for the following:

- Energy Conservation = $2,250,000 per year for 20 years ($45 million total in 2009 dollars)
- Solar PV = $12 million (2011 – assuming Duke can take advantage of solar tax credits estimated at 50% of total capital)
- East Plant = $18 million (2009 – already under construction)
- Natural Gas Conversion of the West Plant = $10 million (2012 – includes boiler conversions and high-pressure natural gas pipeline)
- Biogas Conversion = $25 million (2030)

Debt service on these capital estimates were calculated assuming 6.5% over 30 years except in the case of the Solar PV which was assumed to be paid off in 20 years – the estimated useful life of a PV array. Note that the costs and benefits associated with Green Building were not modeled. For the purposes of this analysis it was assumed that any increased costs for additional energy efficiency measures in new campus LEED buildings will be a part of the specific project costs.

Energy savings and costs were based on the projections of future energy costs provided by Duke's Nicholas Institute for Environmental Policy Solutions and the Climate Change Policy Partnership (CCPP). The projections are based on output from the Adage model assuming Federal carbon legislation is in place in 2012. Since the model outputs are a broad estimate of energy prices across the country, the annual changes shown by the model output were applied to the prices Duke currently pays for coal, natural gas, and electricity. This application provides a projection of future energy cost that is customized for Duke based on current energy costs (see Appendix C).

Changes in maintenance costs were estimated for each option, but a more detailed analysis of these costs will be required before making final decisions on which options to employ. Projections of future carbon values were also provide by the Adage model run by Duke's Nicholas Institute and the CCPP as described previously.



The chart above illustrates the cost effectiveness ratio ($Net Present Value/MTCO2e abated) of each Duke influenced GHG reduction strategy with respect to its energy-related emissions reductions.

Carbon Offsets

Summary Recommendations
With respect to the purchase and/or development of carbon offsets, the Offsets Subcommittee of the CSC advanced the following recommendations to mitigate the remaining emissions following implementation of aggressive on-campus reduction strategies:

- Duke should establish an Carbon Offsets Initiative that will investigate the potential to develop an aggregating entity that could generate high quality, local offsets to meet Duke's and other university's neutrality goals

- Duke should balance fiscal risks and offset goals through a portfolio approach that considers: potential compliance obligations under a federal cap-and-trade or tax; credibility and measurability; cost; community and environmental co-benefits; links to education, research, and service (especially in environment, engineering, business, policy, and law); and mitigation of risk through a diversity of project types, suppliers and locations

- Duke University's offset portfolio should leverage its resources by:
    - Catalyzing offsets opportunities from local and southeastern US sources including partnerships with other NC and SC universities with similar climate neutrality commitments
    - Capitalizing on Duke's reach in the international research community and emphasizing global carbon offsets options
    - Maintaining an active role in project development, as opposed to a passive role as a purchaser
    - Engaging the full range of institutions and schools within its campus. In this capacity, the University should inventory the research, education, and initiatives across its schools and institutes that represent existing or potential engagement in the offsets 'value chain'. It should also identify win-win opportunities that reduce its footprint and further its educational, research and service mission

- Duke University's near term strategy should catalyze pilot offset projects and accelerate preliminary research in NC in at least the following categories:
    - **Swine Waste**—Duke should explore investment in reducing GHG emissions at three hog farms using the methane capture and waste conversion technologies modeled for the Nicholas Institute by Cavanaugh & Associates

    - **Forest Management and Afforestation**—Duke should combine its research with practical application with forest managers, including Duke Forest, NC State forest, and land trusts

- **Energy Efficiency**—Energy efficiency could make a significant contribution to the Durham community and towards Durham's greenhouse gas commitments. Duke should suggest promoting energy efficiency in the community or amongst its employees at their homes, resulting in indirect emission reductions and significant energy cost savings

Background

As the recommendations above indicate and as the CAP anticipates, in order to meet its climate neutrality goal, the University has determined that it must invest in some level of offsets. In 2008, the Nicholas Institute for Environmental Policy Solutions, as part of its report on the feasibility of offsets to meet Duke's climate neutrality goals, estimated that the University would need to purchase by 2035 somewhere between 8.3 to 12 million tons of offsets, measured in carbon dioxide equivalents, depending on the climate neutrality target year.[15]

As part of the development of the University's Climate Action Plan, the Campus Sustainability Committee's Offsets Subcommittee recommended that Duke adhere to the following principles in pursuing carbon offset projects to meet its climate neutrality and potential compliance requirements:

- Pursue transportation and energy initiatives before aggressively offsetting
- Seek out authentic, local offsets to catalyze the local green collar economy
- Learn from early offset experiences

With the recommendations and these basic principles in hand, the Nicholas Institute, in conjunction with Duke's Sustainability Office, undertook a feasibility analysis to evaluate the potential for locally-developed carbon offsets to meet the University's climate neutrality commitment. University leadership particularly asked the Institute to focus on locally-developed projects in order to bring benefits to Duke's community. The Institute identified options for the University regarding both how Duke should consider developing offsets and the types, amount, and estimated costs of local offsets most likely to be available in North Carolina.

Regarding the purchase and/or development of offsets, the Institute evaluated five options for the purchase of offsets, including:

(1) Issuance of requests for proposals (RFPs) or grants for offset procurement;
(2) Over-the-counter purchases;
(3) Membership in an existing voluntary carbon offset exchange;
(4) Procurement from a third party vendor; and
(5) Purchases of offsets by Duke University's Endowment as an investment

[15] This number could be affected by several factors, most significantly by when the University chooses to become climate neutral. In addition, the University's demand for offsets could increase in order to meet compliance requirements for greenhouse gas emission reductions instituted through a federal cap-and-trade regime, and is inversely proportional to the level of on-campus emission reductions that the University is able to achieve. See pp. 13-15 in The Role of Offsets in Meeting Duke University's Commitment to 'Climate Neutrality': A Feasibility Study, The Nicholas Institute for Environmental Policy Solutions and Sustainable Duke, November 2008, available at http://www.nicholas.duke.edu/institute/dukeoffsets.pdf.

Alternatively, the Institute considered how the University might itself become an offsets developer. See p. 31-32. While the option of becoming an offsets developer presents higher risks to the University and exposure to competitors, the Institute observed that becoming an offset developer would allow the University to maintain control over the specific types of carbon-offset-yielding projects it would invest in, provide the University with research opportunities, and support projects with co-benefits for public health and other pollutants.

The Institute also analyzed several categories of local offsets opportunities, including agriculture (e.g., fertilizer management, conservation tillage), forestry (e.g., forest management, afforestation), residential and non-residential energy efficiency projects, landfill methane, and swine waste methane management.

Based on the Feasibility Analysis, the Offsets Subcommittee recommended that Duke consider serving as an offset developer, focusing on swine methane, forestry, and local energy efficiency projects. According to the committee, and after considering the pollution issues associated with lagoon-and-sprayfield systems employed on the state's 2,100-plus farms, investments in swine farm carbon offset projects presented a unique opportunity to develop offsets that could at the same time yield major community and environmental co-benefits, a criteria built into the standards for investment in offsets developed by the Offsets Subcommittee.[16] The Subcommittee also recommended that forestry and energy efficiency projects should rise to the top of the priority list for offset development based respectively on the state's large stores of forested lands and the University's ability to assist in local energy efficiency projects for Durham residents.

To investigate the potential for swine methane offsets further, the Office of the Executive Vice President, through the Sustainability Office, secured the services of a consultant to help the University investigate short and long term options for investments in swine waste carbon offset projects. The investigation indicated that the University could either purchase offsets from existing swine waste technology installations in the short term or work in the long term to create its own projects, over which it would have more control of offset quality. In addition, it illustrated a glaring need in the state for an entity that could develop and aggregate local carbon offsets.

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[16] These criteria include:

- Contribution to 'climate neutrality' or compliance obligations under a federal cap-and-trade or tax
- Credibility and measurability
- Offset cost (measured in $/metric ton of CO_2 eq)
- Community and environmental co-benefits
- Links to education, research, and service (especially in environment, engineering, business, policy, and law)
- Mitigating risk through a diversity of offset project types, suppliers, and locations (local, regional, national, international).[16]

Nicholas Institute, The Role of Offsets, p. 17.

Duke Carbon Offsets Initiative

Understanding this convergence of needs and opportunities, the Executive Vice President, with financial support from The Duke Endowment, has now established an initiative to investigate the potential to develop an aggregating entity that could generate offsets to meet Duke's and other university's neutrality goals and sell offsets in the voluntary and looming mandatory carbon markets. The undertaking includes a one-year appointment beginning on June 1, 2009, of a carbon offsets initiative director to work closely with Duke's Sustainability Director to determine how best to design and deploy a carbon offsets corporation. The initiative will evaluate various business models, and will consider non-profit models as well, and will work with various experts around campus to build the initiative. At the same time, mindful of the immediate opportunities surrounding swine waste, the initiative will be working to deploy at least one swine waste carbon offset project to serve as a proof of concept on technical and economic grounds.

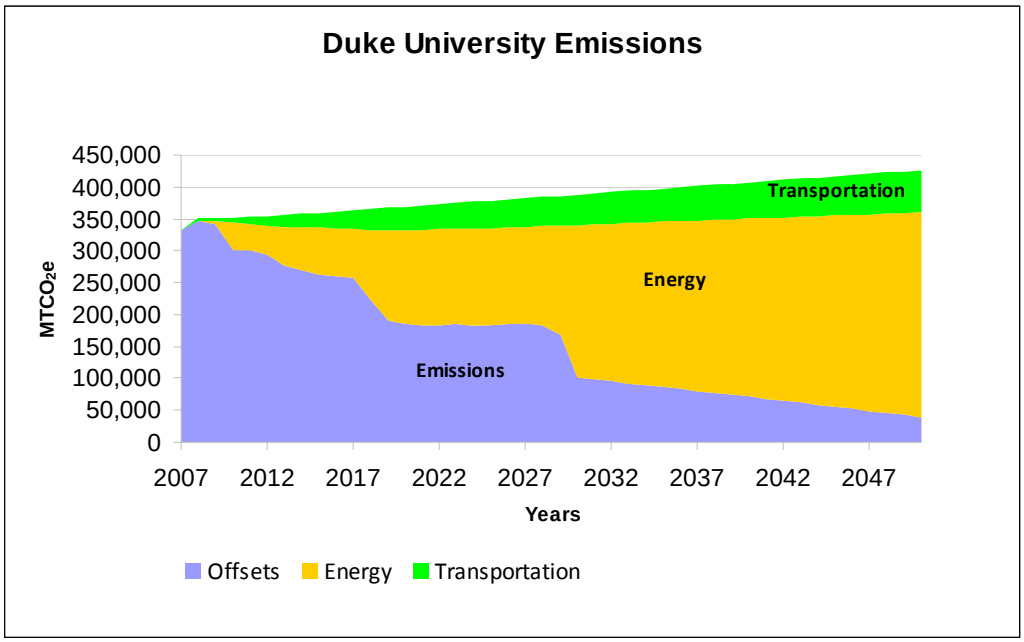
In sum, the University has now launched a proactive approach to meeting its, and potentially others', carbon offset needs. The University has analyzed the types of potential projects in which it could invest, and has directed efforts towards projects that could bring benefits to the local community and the Duke community. The University also has sought to assert control over these efforts, through its carbon offset initiative, so that it will ensure that the projects are investments of which the University can be proud. As the University seeks to implement the Climate Action Plan, it is on pace to ensure that is has sufficient real and verified carbon offsets to meet its neutrality goal.

Targets and Milestones

Options for Neutrality

As Duke has explored its GHG footprint, potential climate neutrality target dates and the required investment related to carbon offsets, it also began the task of identifying the emissions that stem from University[17] operations separately from the Duke University Health System. This segregation of emissions is due to the unique operational requirements and future growth patterns of the two entities. The total GHG footprint for the University emissions in 2007 was 332,972 MTCO2e. Future emission targets will be measured from this 2007 baseline.

The Climate Action plan identifies targets for the University separately from the larger Duke institution, which includes the hospital, outpatient clinics and support facilities for the health system in Durham. As a result, Duke's plan will be more comparable to the plans of the majority of other higher education institutions that do not include their healthcare facilities. While Duke's target neutrality date will only apply to the University, it should be noted that the operational changes and future campus emission reduction measures will also result in a lower GHG footprint for the Health System facilities which are located contiguously with West Campus and share common systems and services.



The graph above shows the potential reduction in emissions of implementing recommended transportation and energy reduction measures within the University compared to a business-as-usual scenario of 426,466 MTCO2e in 2050. Reduction measures such as moving completely

[17] Duke University is located on approximately 8,000 acres in Durham, North Carolina and at the Marine Lab located on Pivers Island in Beaufort, North Carolina. Duke includes undergraduate, graduate and professional schools of business, divinity, engineering, environment, law, medicine, nursing [and as of July 1 2009 public policy].

off coal in the campus steam plant, key energy conservation initiatives, installing solar PV on campus buildings, providing direct financial incentives for alternative transportation and improving regional transportation options are several of the actions Duke will take to reduce the campus carbon footprint to the lowest levels possible. The remaining emissions, in blue, represent what Duke would have to offset to become carbon neutral at a particular year.

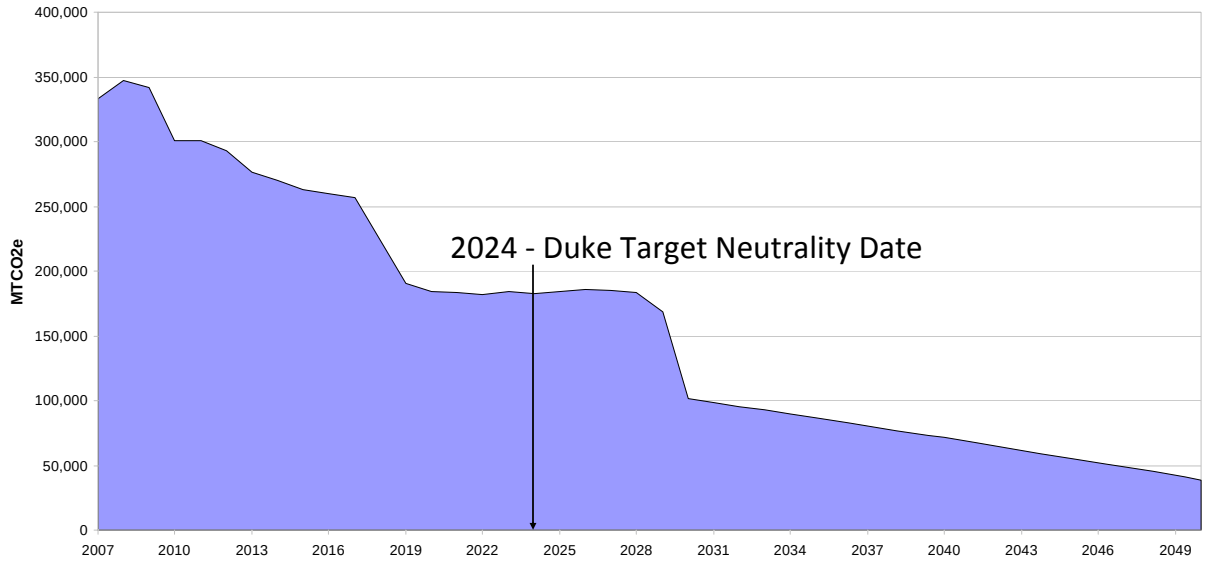
If Duke implements the recommended transportation and energy reduction measures outlined in the preceding sections it will significantly reduce GHG emissions over time and therefore decrease the financial investment in offsets necessary to become climate neutral in the near-term. The table below outlines the financial implications of selecting a particular year out to 2050 for the University's climate neutrality target.

Year	Business as usual emissions	% off 2007 baseline	Offsets Needed to be neutral	Est. cost of offsets* (5% annual increase)
2010	352,245	-10%	300,555	($3,313,617)
2015	359,375	-21%	263,162	($3,702,960)
2020	368,960	-45%	184,307	($3,309,881)
2024	**376,627**	**-45%**	**182,988**	**($3,994,402)**
2025	378,544	-45%	183,900	($4,215,025)
2030	388,128	-70%	101,251	($2,961,845)
2035	397,713	-74%	86,620	($3,233,919)
2040	407,297	-79%	71,278	($3,396,364)
2045	416,881	-83%	55,351	($3,366,141)
2050	426,466	-88%	38,839	($3,014,559)

**These offset prices are based on estimated future market prices. If the Duke Carbon Offsets Initiative moves forward as planned, the University should have many options to meet its need for high quality, local offsets that could require considerably less capital investment than currently modeled.

Duke has thought carefully about selecting a climate neutrality target. There is a need to balance financial implications with the desire for near-term action that could have a more significant affect on global climate change. The University has also considered years that have a particular significance beyond GHG emissions to further engage the campus community. As such, the year 2024, the 100th anniversary of the James B. Duke's Indenture of Trust, has emerged as a date with special significance to the campus that also fits into the other evaluation criteria.

Duke University Projected Emissions to 2050



Assuming the actions noted previously are implemented, Duke will have reduced overall campus emissions by 45 percent in 2024. Energy emissions will be down 44 percent. Contributing to this energy emission reduction is a 58 percent reduction in the GHG emissions from electricity, a 16 percent reduction through energy conservation and green building and a 1 percent reduction with new campus solar PV. Another 25 percent of the 2024 energy emissions reduction stems from moving completely off coal in the campus steam plants.

In 2024, Duke's transportation emissions will be down 49 percent. Emission reductions from air travel, commuter travel and the campus fleet will contribute 63 percent, 32 percent and 4 percent respectively to this decrease. It should be noted that these emission reductions take into account increased fuel efficiency of cars and airplanes as well as expected advances in air traffic management that will reduce the overall impact of this form of travel.

If Duke accomplishes this reduction scenario by 2024, the campus GHG footprint will almost be cut in half from the 2007 baseline. This would leave 182,988 MTCO2e to offset in 2024 to become climate neutral. Based on a rough estimate of offsets priced at $10/ton in 2008 and a 5% annual increase, it would then cost Duke approximately $3.9 million to purchase offsets for the remainder of the campus GHG footprint in 2024 and $91 million in total offset costs out to 2050. If the Duke Carbon Offsets Initiative moves forward as expected, the University will have many options in the future to meet this need for high quality, local offsets. It should also be noted that there is a financial benefit to starting to purchase offsets or invest in offset projects in the near term when the price is lower.

Milestones

As Duke works towards a goal of 2024 for climate neutrality, efforts will also be focused on interim GHG reduction milestones. These include the following reduction percentages every five years starting in 2010, calculated from a 2007 baseline:

- 2010 – 10%
- 2015 – 21%
- 2020 – 45%
- 2025 – 45%
- 2030 – 70%
- 2035 – 74%
- 2040 – 79%
- 2045 – 83%
- 2050 – 88%

While expected campus growth assumptions, economic conditions, and Duke Energy's potential emissions reduction, could have a significant impact on Duke's ability to meet these reduction goals, it is still important to have short term milestones to measure and assess progress.

More specifically, Duke will be focusing efforts on energy and transportation projects to meet campus GHG reduction goals. Short term milestones in energy GHG reduction include:

- **2010** – East Campus Steam plan comes online – 86% reduction in coal use, 34% reduction in steam plant GHG emissions from 2007 baseline
    - Green Building
        - Establish a Duke University approval protocol for new building energy consumption approval and expand current LEED building policy to establish green building energy consumption standards for immediate use
        - Implement energy use targets by Tech Rating
    - Energy Conservation
        - Initiate study to develop plan for Energy Conservation Measures (ECMs)
        - Determine contracting method for ECMs and start implementation with goal of 15% reduction by 2030
- **2012** – Install 4MW solar PV array, 1.3% reduction in GHG emissions from 2007 baseline; initiate West Campus steam plant conversion away from coal completely – 41% reduction in steam plant GHG emission from 2007 baseline

Short term transportation GHG reduction goals include:

- **2012** –
    - Commute Reduction
        - Create or redirect existing resources for a Transportation position to market alternative commute options
        - Expand transit subsidies, carpool incentives, and vanpools funded through increased parking prices
        - Develop Park and Ride lot(s)
    - Fleet
        - Begin process to replace 10 buses with hybrid BRT's (Bus Rapid Transit)

        - Eliminate H5/H6 shuttle routes (that would be unnecessary with new Park and Ride)
        - Establish a "green" fleet procurement policy
    - Air Travel
        - Develop Duke air travel policies and guidelines as well as better tracking mechanisms for air travel data by department
- Outcomes:
    - About an 6 percent reduction in single occupancy vehicle (SOV) travel
    - About a 4 percent reduction in parking demands
    - About a 33 percent increase in transit use
    - About a 4 percent reduction in air travel emissions
    - An estimated 6 percent reduction in transportation-related GHG (over 2007 base)

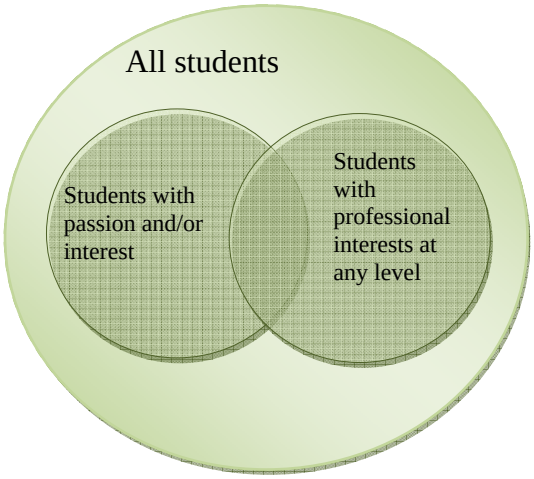
- **2017**
    - Commute Reduction
        - Further efforts by Transportation Coordinator
        - Broaden Park and Ride program
        - Explore parking pricing increases (+/- 50 percent)
    - Fleet
        - Replace 10 additional buses with hybrids
        - Advance greening of service fleet
    - Air Travel
        - Continue implementation and education about air travel policy

- Outcomes:
    - About a 4 percent additional reduction in SOV vehicle travel
    - About a 3 percent additional reduction in parking demands
    - About a 8 percent reduction in air travel emissions
    - An estimated 10 percent reduction in transportation-related GHG (over 2007 base)

Educational, Research, Community Outreach

Summary Recommendations

The following are recommendations advanced by the Education Subcommittee of the CSC to describe plans to make sustainability and climate neutrality part of the educational experience for all students; and plans to expand research and community outreach on sustainability throughout the institution.



- Duke should charge a campus committee to consider incorporating sustainability into the depth and breadth of the student experience. This group could consider tactics such as a "mode of inquiry" focused on environmental citizenship, literacy and sustainability or expanding existing efforts to integrate sustainability priorities into recruitment and orientation materials

- Duke should consider expanding programs to support two particular subsets of students: (a) students with a passion/interest in the environment, and (b) students with a professional interest in the environment and sustainability.

    - For students in group (a), tactics could include: expanding the peer-to-peer program, Students for Sustainable Living, or exploring new academic and service programs with sustainability themes, including FOCUS, seminars, DukeEngage, or study abroad

    - For group (b): tactics could include: exploring how existing or new certificate programs could provide evidence of knowledge of climate change and sustainability to potential employers and preparing students both for careers that are primarily in the area of climate change and sustainability, and for those where these concepts are infused or integrated into a job with other primary responsibilities

- Duke should continue to foster new and existing research efforts in sustainability and climate change. Tactics might include: establishing a conversation among researchers involved with sustainability and climate change, to determine the areas in which they see a need for increases in research and potential options to incentivize these endeavors

- Duke should continue to foster knowledge in service to society through creative partnerships in the local community

Introduction

This section of the document recommends processes by which Duke can (a) improve environmental citizenship and literacy of students, staff and faculty, (b) expand research in sustainability, and (c) expand community outreach towards sustainability.

The institutional motivation for such efforts at Duke goes well beyond crafting this Climate Action Plan. First, many environmental challenges are at a critical juncture where knowledge and action are needed imminently, and the awareness of this among the general public and policy makers is at an all time high. Second, Duke has unique strengths to address these needs, including academic, facility, and personnel resources. Third, a number of efforts on sustainability by colleges and universities beyond the Presidents Climate Commitment have momentum [18]; and many peer institutions are making sustainability efforts a priority on their campuses. Fourth, the prospective student pool for future first year Duke undergraduate classes may well consider environmental responsibility as a part of a college choice decision, and so Duke's efforts in these areas may have measurable impact on recruitment and matriculation to future undergraduate classes.[19]

With regard to student experience, this document will address three sectors as depicted in the Venn diagram on the previous page: all students, students with passion, and students with professional interest. In each case, Duke's current and ongoing efforts will be summarized, and future goals for the Climate Action Plan will be established and described.

Goal: Sustainability and Climate Neutrality Become a Part of Every Student Experience

Environmental citizenship for all Duke students is an ambitious but worthy goal. Many options exist at Duke to provide educational opportunities to all students in sustainability and climate neutrality, but the Campus Sustainability Committee realizes that the spirit of the Commitment asks for these aspects to not just be opportunities or concept exposure, but rather concrete experience. Duke supports this spirit, and will engage in a thoughtful internal discussion of what that means for students, both undergraduate and graduate.

Current and Ongoing Efforts

Current efforts at Duke whereby all students are exposed to concepts and practices of environmental citizenship and sustainability are primarily co-curricular in nature, and are

[18] AASHE – the Association for the Advancement of Sustainability in Higher Education (www.aashe.org);
The Talloires Declaration (http://www.ulsf.org/programs_talloires.html), an international effort that began in 1990 and encourages institutions to incorporate sustainability and environmental literacy in teaching, research, operations and outreach at colleges and universities. It has been signed by over 350 university presidents and chancellors in over 40 countries (Duke is not one).

[19] In 2007, the Princeton review announced their first green ratings of college campuses, a recent article in the *Chronicle of Higher Education* reported that a quarter of entering first-year students were "preoccupied" with going green (2008 01 24), Kaplan has announced that 63% of students surveyed might use environment to choose a campus, and AASHE is developing a Sustainability Tracking and Rating System (STARS) by which colleges and universities will publicly display their strengths and challenges in these areas.

described in more detail below. Through Duke's Nicholas School of the Environment, students have a myriad of opportunities to choose classes, majors, minors, certificates, and other special programming that incorporate these topics in an academic sense.

Duke has a number of venues where sustainability and climate neutrality are integrated into the experience of all first-year students. Duke's orientation guide, sent to matriculating Duke first year students contains information on Duke's sustainability efforts. In addition, for the last two years, Duke's first year orientation picnic has been a waste-free event, including education for attendees on the reasons for such efforts. Duke's student group, Environmental Alliance, in conjunction with Duke's Sustainability Office, has organized the Eco-Olympics each year since 2002 where all the first year dorms compete to have the highest reduction in water use, electricity use and waste generated (http://www.duke.edu/sustainability/news_events/items/2008_10_01EcoOlympics.html).

Duke also has numerous areas where all students are exposed to sustainability and climate neutrality concepts and practices. Duke regularly implements "Recyclemania" throughout campus, a competition to reduce waste. Other special events have included eco-week in Crowell Quad (2007-2008), sustainable art projects outside of various residence halls, and residence dialogues on interactions between environment, race, and culture. Through "Move Out for Charity" students are regularly encouraged to donate clothing and other used items instead of putting them in the trash at the end of the school year. The faculty-in-residence in Southgate Hall is a member of the Nicholas School faculty, and has engaged residents to participate in multiple initiatives to turn off lights, recycle, and shut down air conditioning units when not needed. Many initiatives involve students in reducing water and electricity use on campus and in generally helping to conserve campus environmental resources. Special efforts have been made to encourage the use of recycling bins in selective living groups after large parties, and bin locations are constantly modified and tested for optimal use. Recycling at large athletic events is being expanded, with proceeds from these events going to Duke Children's Hospital.

Social marketing or more passive types of communication and education efforts are also present on campus. Residence halls have a number of types of signs to remind and educate, such as signs to save water near faucets, laundry and shower; to remind users how to flush to save water; to remind users to turn off lights, and to teach about energy efficient thermostat usage. Other signs remind students and other users to recycle in dormitories and computer labs. Bulletin Boards in residence halls give tools for tolerance and for water conservation. Use of these bulletin boards and hall websites reduce paper use overall (fewer fliers are printed and posted).

Future Goals

Despite the many opportunities that students can choose regarding environmental science and policy, sustainability, and climate change, Duke does not currently *require* sustainability or climate neutrality to be a part of the curriculum for all students. The means by which this goal could be accomplished could include a wide spectrum of academic options, from courses that

are a part of a *major, minor, or certificate*, to those with environmental *emphasis*, to those that are environmentally *related*, to courses that use environment purely as an integrating context (*EIC*)[20]. One tactic Duke could employ is a curricular component termed "mode of inquiry," that would link all students to environmental citizenship and sustainability regardless of major. This vehicle is versatile and effective, and provides a menu-based approach to completion of a curricular requirement. As a first step towards this goal, Duke should consider what criteria would define courses as providing these concepts and practices. When criteria are identified, Duke could begin to track courses currently being provided on campus that meet these criteria. In addition, although efforts for undergraduate students, and efforts for some graduate and professional schools exist, efforts for other graduate student entities could be improved.

Specific recommended future goals are listed below:

- As the curriculum is reviewed over the long-term, consider how the current "mode of inquiry" might be modified to provide introduction to the concepts and practices of environmental citizenship, literacy, and sustainability

- Develop conversations with all graduate and professional schools to consider how best to include these concepts and practices for their students' experience

- Expand on existing efforts to integrate sustainability priorities into recruitment materials for all graduate and undergraduate applicants, and into orientation materials and activities for all graduate and undergraduate matriculants

- Develop and implement social marketing programs to encourage responsible environmental behavior choices and expand passive learning opportunities on campus around sustainability

Goal: Provide Opportunities for Students with Passion, Commitment, and Interest

With student input and energy, Duke could implement a wide variety of new programs and initiatives to encourage, support, and display student interest in the environment. Duke is a campus with many disparate student populations, including undergraduates; students pursing professional degrees such as law, engineering, medicine, business, policy, nursing, and environment; and students pursuing master's and doctoral degrees through the graduate school. The interests and pursuits of Duke students are multi-faceted and defy simplistic approaches to meeting needs of commitment and interest. In addition, the leadership, administrative, and infrastructure realities of the Schools supporting these students vary substantially, and therefore, determining how to best reach students with particular interest in,

[20] EIC= using the **E**nvironment as an **I**ntegrating **C**ontext, a term coined by Jerry Leiberman and the State Environment and Education Roundtable. In this report, EIC is used to mean authentic integration of environmental issues and contexts in courses that may have other disciplinary homes and primary instructional goals (e.g., using fish population information in problems to illustrate area under a curve in calculus).

passion for, or commitment to environment is wonderfully complex. A wide variety of programs could be designed and implemented to identify and support students at every stage in development of this interest.

Current and Ongoing Efforts

Duke's Nicholas School of the Environment (which opened its doors in 1938 as the School of Forestry) provides educational opportunities for students at the doctoral level (PhD), graduate professional level (Master of Environmental Management and Master of Forestry), and undergraduate level (http://www.env.duke.edu/). The school also offers undergraduate and graduate courses at the Duke Marine Laboratory in Beaufort, and a continuing education program (Duke Environmental Leadership program) including a master's program for mid-career professionals and certificate and short courses. The Nicholas School cooperates with Trinity College of Arts and Sciences in awarding four undergraduate degrees: AB and BS in Environmental Sciences, and the AB and BS in Earth and Ocean Sciences (http://www.env.duke.edu/programs/undergrad/). Courses for the majors are taught by more than 60 Duke professors in 20 cooperating departments and schools. Students may also elect to earn a minor in any of these areas. Appendix D contains a list of sample courses in sustainability-related topics offered to undergraduates at Duke in the 2008-2009 academic year. Over 200 graduate students entering the Nicholas School seek graduate professional degrees, preparing for careers as expert environmental problem-solvers after two years of study (http://www.env.duke.edu/programs/professional/). The Master of Environmental Management degree trains students to understand the scientific basis of environmental problems, as well as the social, political and economic factors that determine effective policy options for their solution. The Master of Forestry (MF) degree develops experts in sustainable management of forested ecosystems. Approximately 50 doctoral students prepare for university teaching and research through the Nicholas School directly, or through combined programs such as the Program in Ecology, or the Program in Integrated Toxicology (http://www.env.duke.edu/programs/doctoral/).

Many Nicholas School courses (both graduate and undergraduate) are cross-listed with other campus departments, and some other departments also have their own courses with content that focuses on, or is highly related to, sustainability and climate neutrality. For example, the Pratt School of Engineering has a course on Energy and Environment Design, and leads a first year student FOCUS Program entitled "Engineering Frontiers: Living systems for a living planet" (http://focus.aas.duke.edu/program/clusters/engineering_frontiers.php).

In addition, several certificate programs exist for interested students, each of which contains required and elective courses, and a capstone academic experience. A Certificate in Energy and the Environment is designed to provide Duke undergraduates with an understanding of the breadth of issues that confront society in its need for clean, affordable and reliable energy (http://www.nicholas.duke.edu/programs/undergrad/energycert.html). A Marine Science Conservation and Leadership Certificate develops leadership skills in a marine science and conservation context, and requires one semester residency at the Duke's Marine Laboratory (http://www.nicholas.duke.edu/marinelab/programs/certificate.html). Graduate students may

earn a Certificate in Geospatial Analysis by completing a series of core and advanced course requirements and demonstrating proficiency in application of these skills in the completion of an environmental or earth science research project (http://www.nicholas.duke.edu/geospatial/certificate-program).

Duke has several existing programs that cross the boundaries of curricular and social learning. One of these is the flagship DukeEngage program, which has a number of summer immersion programs for students that provide an environmental context (http://dukeengage.duke.edu/immersion/durham). Duke's Study Abroad program offers a number of programs with strong and integrated interdisciplinary environmental components, such as Duke's program in South Africa through the Organization for Tropical Studies (http://studyabroad.duke.edu/home/Programs/Semester/OTS_South_Africa).

Students with a passion for the environment may join one of several very active student organizations. The Environmental Alliance (EA) is primarily an undergraduate group (http://www.duke.edu/web/env_alliance/), whereas the Duke University Greening Initiative (DUGI) is primarily made up of graduate students (http://web.duke.edu/greening/). The Duke Sustainability Office leads a group of students, Students for Sustainable Living, in a number of activities that specifically benefit Duke's climate footprint. For their efforts, the students earn a small financial stipend. Other student groups include the Green Wave at Duke's Marine Laboratory, the Fuqua Business School's Net Impact club, Duke Bike Advocates, WOODS, and Project Wild (http://www.duke.edu/sustainability/student_groups/index.html). A new organization, Farmhand, takes graduate and undergraduates to local sustainably operated farms to spend a day working for the farmer in return for lunch and educational conversation (http://www.nicholas.duke.edu/people/students/orgs-farmhand.html). Farmhand has established a community garden at the Duke Gardens, which has raised beds for gardening, bee hives, and organic composting.

Duke recently completed construction of the Home Depot SmartHome (http://smarthome.duke.edu/home/). About 15 undergraduate and graduate students live in the LEED platinum building, which provides practice in sustainability in addition to many engineering research projects for residents. Recently several student groups have joined forces to establish a community garden between the SmartHome and the Freeman Center for Jewish Life, which has vegetables and composting, with plans for fruit and nut trees.

Many special events occur each year at Duke. For example, in the spring of 2008, the Quad Council provided reusable Nalgene water bottles to interested members of the campus community. A waste-free first year picnic welcomes students and their parents when they first come to Duke. Earth Month at Duke is always an enormous and multi-dimensional event at Duke; in 2009 it culminated with the social events of the Last Day of Classes, and this entire campus-wide event had a green-theme both in content and practice.

Appendix D contains a matrix with many ongoing special events and other efforts on Duke campus.

Future Goals

Duke is committed to considering how to identify those students with particular passion, interest, and commitment to sustainability, and how to encourage them in their interest and commitment. Note that these suggestions explicitly do not distinguish between "curricular" and "co-curricular" ideas. It's important to acknowledge that the line between the two is oft-blurred, and that this murkiness is often advantageous to the student learning experience.

Recommendations:

- Duke could expand its peer-to-peer program based on the success of these programs at other institutions. Duke's current Students for Sustainable Living program provides a good exemplar. Other schools use students in residences, clubs and organizations, and campus events as liaisons to achieve two-way communication about what is and is not known, and what choices can, and perhaps should, be made

- Explore implementing new academic and service programs with sustainability themes, including FOCUS, seminar, DukeEngage, study abroad, out-of-doors options

- Explore the creation of additional sustainability-themed housing, based on student interest. Duke has recently surveyed the student body to assess interest in such a housing option. Results of the survey should be available shortly

- Encourage and support inter-campus conferences addressing environmental education and sustainability both at Duke and elsewhere attended by Duke students

Goal: to Reach Students with Environment as a Professional Goal at Any Level

Duke could better expose students to knowledge, skills, and opportunities in the burgeoning field of careers in environment. The number of career options in the environmental field is increasing at such a rate that career professionals are hard pressed to keep up, especially when considering the need to integrate environmental knowledge into the skill set of students in fields where this was previously absent (and arguably seen as unnecessary). Duke has a real opportunity to be on the leading edge of providing students with exposure to such knowledge and experience with related skills. These experiences can enable students to help Duke and other organizations with whom they will become affiliated to achieve their own climate neutrality goals.

Duke has well-known paths to environmental majors and minors. However, Duke can support students in other majors and minors who will find that the environment plays an increasingly important role in jobs that are not primarily seen as being in the environmental sector. Duke should continue its strong effort towards interdisciplinarity, with a focus on sustainability initiatives.

Current and Ongoing Efforts

Interest in careers in the environment has been steadily increasing, and Duke's Career Service Center has responded in kind for undergraduate career advising. In addition, the Nicholas School of the Environment has a sophisticated and creative Career Services operation (http://www.env.duke.edu/career/) where both graduate and undergraduate students can obtain information and suggestions. Through the innovative Stanback Interns Program, both undergraduate and graduate students can "test-drive" career possibilities while earning a stipend and serving an entrepreneurial and/or not-for-profit organization (http://www.nicholas.duke.edu/career/stanback2009/).

Future Goals

Duke should endeavor to prepare students both for careers that are primarily in the area of climate neutrality and sustainability, and for those where these concepts are infused or integrated into a job with other primary responsibilities. When such careers are identified, Duke staff should work with employers to identify the skills needed, and with faculty, staff, and students to develop those skills and the means of documenting to prospective employers that the skills have been learned.

As an initial step, Duke could provide evidence of knowledge of climate neutrality and sustainability through a certificate program. This could be through development of a new certificate or through integration of these topics in the current certificate in Energy and Environment. In addition, collaboration with current initiatives around certificates in Energy and Environment at several professional schools (Fuqua (business), Sanford (policy), and Law) could be investigated.

Research Efforts

Duke should build upon the goal of "knowledge in service to society" by encouraging and supporting research in sustainability with the objective of becoming a national leader in research areas such as climate neutrality, sustainability, and corporate stewardship. Early and mature research should be supported, both from faculty and student aspects.

IV.5.A. Current and Ongoing Efforts

The Nicholas School of the Environment and Earth Sciences is composed of three research divisions, which primarily serve doctoral students, and house some 11 research centers and programs.

- Marine Science & Conservation, with focal areas in marine ecology, estuarine processes, and coastal geology, is headquartered at the Duke University Marine Laboratory at Beaufort, N.C. Faculty research interests range from studies of the long-line fisheries industry, to monitoring and assessing the post-hurricane health of the Neuse River and Pamlico Sound, to the effects of human activities on marine mammal populations, to applications of social science to environmental policy and management

- Earth and Ocean Sciences, with focal areas in climate change, solid earth processes and surface processes, is headquartered in the Old Chemistry building at Duke. The Faculty at EOS conduct research all over the world, from Hess Deep (-3200m depth) in the Pacific Ocean to the 4000m+ altitudes of the South American Altiplano

- Environmental Sciences and Policy, with focal areas in ecosystem science and management, environmental chemistry and toxicology, aquatic and atmospheric sciences and environmental social sciences, is headquartered in the Levine Science Research Center. Faculty with training in the biological, physical, chemical and social sciences work on applied and basic environmental research problems. The division stresses interdisciplinary approaches to environmental problem solving

The Nicholas School website – (http://fds.duke.edu/db/Nicholas/faculty) contains a list of faculty currently at the Nicholas School with such interests and affiliations. In addition to the Nicholas School, Duke's Nicholas Institute has named climate change and energy as focus areas of interest (http://www.env.duke.edu/institute/knowledge-climate.html). Duke also has a number of Centers that work on sustainability, such as the Climate Change Policy Partnership (http://www.env.duke.edu/ccpp/), which researches carbon-mitigating technology, infrastructure, institutions and overall systems in order to inform lawmakers and business leaders as they lay the foundation of a low-carbon economy.

In addition (and in collaboration with) the Nicholas School, faculty throughout Duke in these arenas work on areas primarily or secondarily focused on global climate change and sustainability.

- Many faculty of the Pratt School of Engineering conduct work in sustainability and environmental engineering (http://www.pratt.duke.edu/research-news?keywords=Environmental). Some of this work has direct implications for campus environmental management. For example, over the last ten years, Dr. Miguel Medina, a professor in the Department of Civil and Environmental Engineering, and his students have painstakingly modeled the flow of stormwater on campus. It is thanks to their efforts that Duke can boast one of the most comprehensive Stormwater Management Plans of any university. Besides helping Facilities Management incorporate better stormwater detention, retention and filtration strategies into campus design, Medina has teamed up with Curtis Richardson to build an 8-acre wetland and retention pond just south of Duke's West Campus. When the project is finished, it will catch and cleanse the run off from 1,600 acres of Durham and Duke.

- Duke's Corporate Sustainability Initiative is a joint venture between Duke's Nicholas School of Environment, Fuqua School of Business, and the Nicholas Institute of Environmental Policy Solutions with a two-fold mission: advance the

theory and practice of corporate sustainability, and enable the next generation of sustainable business leaders. Many of the on-going research and corporate projects relate directly to sustainability and climate change (http://www.nicholas.duke.edu/csi/research.html).

- Numerous faculty in the Department of Biology have research interests with direct application to sustainability and climate change (http://fds.duke.edu/db/aas/Biology/faculty/ecology.html). For example, research in Dr. Jim Reynolds' lab focuses on the direct effects of disturbance (e.g., drought, overgrazing, land-use change, elevated CO2 concentrations) on dryland ecosystems. Desertification (land degradation in drylands) is a phenomenon often equated to a reduction in the biological and economic potential of land to support human populations, livestock and wild herbivores and which, ultimately, is linked to global environmental change through climate, biodiversity loss, human dimensions, and land use change.

- The Sanford School of Public Policy has a number of efforts and linkages that produce research and learning outcomes related to environmental policy endeavors (http://pubpol.duke.edu/research/). Sanford is a primary partner in the Nicholas Institute for Environmental Policy Solutions.

Future Goals

Duke should continue to foster new and existing research efforts in sustainability and climate change. Tactics might include: establishing a conversation among researchers involved with sustainability and climate change, to determine the areas in which they see a need for increases in research and potential options to incentivize these endeavors.

Community Outreach Efforts

Duke has numerous community outreach efforts whereby students, faculty, and staff work within Durham, North Carolina, the U.S., and internationally, and many of these involve elements of sustainability and climate neutrality.

Current and Ongoing Efforts

The Children's Environmental Health Initiative of the NSOE participates in numerous community action coalitions advocating for more effective and responsible public policy and governmental action (http://www.nicholas.duke.edu/cehi/about/contact.htm). For example, these actions include lead poisoning outreach, monitoring of environmental and water quality in public housing, and using computer mapping to generate data on health and the built environment. A number of undergraduates intern within this Initiative.

The Net Impact Club at the Fuqua School of Business maintains a "curriculum change" committee to encourage faculty and administration to further incorporate social and environmental business concepts into the curriculum (http://www.dukembanetimpact.org/). In addition, the recently launched Corporate Sustainability Initiative, a joint program between

Nicholas and Fuqua, is working to create a curriculum around sustainability to serve both MBA and MEM students.

DukeEngage is a flagship student service program, which has an expanding base of volunteers doing work in sustainability. Since fall 2007, volunteers have worked with Clean Energy Durham to reduce energy use in low-income Durham residences. This coming summer, in addition to the work in Durham, a new site will commence where 10 to 12 students will work with environmental organizations in the Willamette Valley of Oregon.

Duke's Neighborhood Partnership Initiative works actively with residents and other concerned citizens in the 12 neighborhoods closest to campus (http://community.duke.edu/duke/). Since 2005, the Durham Community Land Trustees, Habitat for Humanity and Self-Help have built 45 certified energy efficient homes in cooperation with the neighborhood-based Quality of Life Project in the Duke-Durham Neighborhood Partnership communities of Southwest Central Durham. These homes are certified to meet the federal Energy Star for Homes standard and North Carolina's SystemVision standard which ensures the homes are comfortable, durable, safe, healthy and energy efficient. Each of the 45 certified homes prevents the yearly release of approximately 2,500 pounds of carbon dioxide, one of the main contributors to global warming, compared to a non-certified home of the same size. As a whole, these 45 homes reduce carbon dioxide emissions by 112,500 pounds per year.

Future Goals

In the future, Duke could partner with community agencies in our region as appropriate to achieve multiple goals: (a) student learning, (b) community service, and (c) carbon offsets. One potential collaborative community partner identified by the Offsets Committee is Clean Energy Durham mentioned above in the DukeEngage paragraph.

Communication

Summary Recommendations
The following recommendations were advanced by the Communications Subcommittee of the CSC with the goal of moving beyond simply distributing information to promote changes in behavior among students, faculty and staff in ways that directly impact the reduction of greenhouse gas emissions at Duke.

- Duke should build community for grassroots engagement, through existing and new sustainability networks, to enhance awareness of campus sustainability efforts among internal audiences and the impact of their decisions on greenhouse gas emissions

- Duke should foster changes in behavior among internal audiences that reduce greenhouse gas emissions at Duke through tactics such as issuing campus challenges to change individual behavior and engaging community members at points of access

- Duke should set goals, measure and report on progress through tactics such as making climate change personal to the campus community with the development of a Duke specific carbon calculator and telling stories through the eyes of others

- Duke should enhance perception of the University internally and externally as a sustainability leader in higher education through tactics such as development of a sustainability media kit, branding the Climate Action Plan and developing an email engine to communicate sustainability initiatives

- Duke should leverage the University's unique attributes through research, sharing and implementing change in the local community

Background
During the last several years, Duke has made significant strides in promoting its sustainability efforts based on the following five key strategies –

- Leadership
- Identity
- Create Buzz
- Coordinate Communications
- Think Bumper Stickers

See Appendix E for a review of communication efforts and accomplishments over the past two years. The current communication plan is designed to support Duke's participation in the American College & University Presidents Climate Commitment and the efforts to reduce the emission of greenhouse gases and develop institutional plans to achieve climate neutrality in the future.

While much of the impact on reducing greenhouse emissions will likely be made at the institutional level (sources for energy use, fuel mix, purchase of offsets, etc.), individuals who work, study and live on campus will also play a significant role. Thus, the focus of this communication plan must move beyond simply distributing information to educate or increase awareness; it must help foster changes in habits and behavior among students, faculty and staff in ways that directly impact the reduction of greenhouse gas emissions at Duke.

For this reason, the communication plan will focus largely on the areas where individual choices can impact Duke's carbon footprint. Those areas are typically: energy use/conservation and transportation.

Communication Objectives

- Enhance awareness of Duke's sustainability efforts among internal audiences and the impact of their decisions on greenhouse gas emissions.
- Foster changes in behavior among internal audiences that reduce greenhouse gas emissions at Duke.
- Enhance perception of Duke internally and externally as a sustainability leader in higher education.

Communication Strategies

1) **Build Community for Grassroots Engagement:**
   Concerted efforts should be made to foster a "green" community on campus that can help carry the message and empower change at Duke. As of May 2009, more than 3,200 students, faculty and staff have taken the Sustainable Duke pledge. These individuals and other environmental groups on campus can work from the bottom up to help fuel local communication and identify opportunities to reduce greenhouse gas emissions at the department level.

   Employing an effective grassroots effort will still require central support and coordination, much like a political campaign. This central support can also serve as a conduit for raising ideas and suggestions to administrative units for consideration. Through centralized support, regular communication and tools can be provided to self-identified ambassadors to help empower them to solicit support among others and make changes at the local level. Support could be modeled after grassroots political efforts such as MoveOn.org and include regular emails to those who have taken the pledge, a Facebook group, a community blog, events and social gatherings.

2) **Set Goals and Measure Them**
   People generally like seeing progress and contributing to it. The recent water conservation efforts proved that individuals at Duke can work together to make a significant impact. Establishing and measuring goals will help individuals see progress in quantifiable terms, which can help energize and empower those advocating for change.

Broad goals for reducing greenhouse gas emissions such as consumption of electricity, water, etc. should be established so individuals can track the impact of their collective efforts. More targeted goals such as a Sustainable Duke pledge drive or a ride-the-bus campaign should also be established to drive participation in specific efforts during the year. These goals can be tracked and reported on the Sustainability website.

3) **Leverage Duke's Unique Attributes**

Last year, Duke took advantage of the national audience for a men's basketball game to help promote Duke's sustainability efforts. The event was viewed by more than 1.46 million people and led to significant positive exposure for many months afterward. Duke should continue to seek to use its unique attributes to promote its sustainability efforts and engage students, faculty and staff.

Developing events or activities around basketball and other athletic events provide Duke an opportunity to capture the attention of broad audiences, including media and the public. Duke's research endeavors and natural resources such the Duke Forest and the Sarah P. Duke Gardens offer other opportunities to promote sustainability. Hosting a lecture series that included Nobel Peace Prize winner Al Gore and other sustainability leaders could help Duke be recognized for its research and efforts. Another option might be hosting a sustainability film festival to coincide with and complement Durham's Full Frame Film Festival.

4) **Make it Personal**

When talking sustainability, some of the concepts can be abstract or complex, and institutional inventories of kWh, Btu and metric tons can be hard for individuals to put into perspective. When possible, global or institutional numbers should be framed within a relative context for the individual (e.g. Duke electricity use is comparable to the electricity used in every home in Orange Co.).

In addition, personal stories of how people at Duke are supporting sustainability can help illustrate best practices that others can adopt in their work or personal lives. These stories can also help recognize individual efforts and provide potential content for media stories.

5) Take Advantage of Media Opportunities

Duke communication professionals and faculty should continue to foster relationships with environmental/sustainability reporters to help promote the university's sustainability efforts and take advantage of opportunities that arise to garner significant national attention. During the "green" basketball on ESPN2 in 2008, Duke received significant exposure that resonated for months with additional media attention through national outlets such as The Weather Channel and USA Today. Whether through athletics, faculty research or prominent speakers such as Robert Redford, Duke should seek to leverage these events to help promote Duke's standing as a leader in sustainability.

Local and regional media opportunities should also be pursued. The volume of such stories can create a critical mass that would lead a reporter for a national outlet such as The Chronicle of Higher Education to consider Duke as an example for a sustainability trend article.

Communication Tactics

1) **Email Engine**
   a. Identify and use a more sophisticated tool for managing email lists to help engage faculty, staff and students who have pledged to support sustainability.
   b. Take advantage of web metric tools to collect data on use of email newsletter and messages to better understand audiences and readership trends to target information more effectively.
   c. Develop a design for email newsletters/messages to be more visually engaging.

2) **Set Challenges**
   a. Develop and promote sustainability challenges on a regular basis to encourage behavior changes among students, faculty and staff.
   b. Measure results of targeted challenges (e.g. increase bus ridership) and communicate to increase awareness and promote sustainable behaviors.
   c. Take advantage of signage and communications to deliver "Did You Know" facts to foster greater awareness and understanding of sustainable issues on campus.

3) **Carbon Calculator**
   a. Create and promulgate a web application to allow people to input their personal data to measure their own personal, Duke-specific, carbon footprint.
   b. Provide tips to help students, faculty and staff to reduce their carbon footprint.
   c. Track, measure and promote individual and collective progress across Duke to help raise awareness about the impact of each person's behaviors on sustainability.

4) **Committee coordination**
   a. Use exiting environmental groups (Duke University Greening Initiative, Environmental Alliance, Students for Sustainable Living) to help promote events and distribute messages among their respective audiences. These groups have existing networks and organizational histories and can be harnessed through central coordination to better engage the Duke community.

5) **Expand the network**
   a. Go where the audience is by creating a presence on social media networks Facebook, MySpace, YouTube, Twitter, etc. to promote events and activities.
   b. Create a Sustainable Duke presence on primary Duke sites such as Duke Pass, Duke Today and Inside Duke Medicine.

c. Drive people to the Sustainable Duke site and encourage all students, faculty and staff to take the pledge, which will add them to the mailing list for future updates.

6) **Brand the Climate Action Plan**
   a. Develop a common visual identity to help create awareness about the Climate Action Plan, the goal and the related efforts to reduce Duke's carbon footprint.
   b. Use identity with articles, signage, events, etc. to enhance visibility of sustainability and progress toward climate neutrality across Duke.

7) **Engage at the points of access**
   a. Add branding messages and call to action prompts at various points of access where individuals make choices that impact sustainability:
      i) Entrance to parking lots, garages
      ii) Light switches in buildings
      iii) Computer login screens
      iv) Inside Duke buses
      v) Laundry rooms in residence halls
      vi) Thermostats in buildings

8) **Expand reach through the use of video**
   a. Add "shorts" before films in Griffith Theater to help promote sustainable efforts and sustainable behaviors among the Duke community.
   b. Host film festival in conjunction with Full Frame Film Festival to show environmental films on campus.
   c. Create opportunities for student involvement (Froshlife, Nicholas contest, etc.)
   d. Create a dedicated channel on YouTube to promote sustainable efforts**.**

9) **Develop Media Kit**
   a. Create flexible media kit that can include a range of materials as needed to promote Duke's efforts at events, conferences, etc.
   b. Develop print and electronic versions that are capable of being customized and delivered quickly distributed to address just-in-time activities and issues.

10) **Tell stories through the eyes of others**
   a. Bring abstract concepts to life by writing and promoting stories of individuals who have made changes that support a more sustainable environment at Duke.
   b. Recognize those doing it right and offer examples for others to emulate.

11) **Duke vs. UNC**
   a. Take advantage of captive audience of ACC rivals to foster a greater awareness of sustainability efforts and garner media exposure as a leader in sustainability.
   b. Extend challenges to local ACC schools to create a productive competition among schools to reduce carbon footprints on campus.

12) **Celebrate the beginning, focus on the end**

a. Develop a rollout plan to kick-off the Climate Action Plan.
b. Foster a sense of excitement to create momentum to change behaviors to become a climate neutral campus.
c. Focus on the greenhouse gas inventory and the efforts necessary to reach the goal.

By focusing on these communication strategies and tactics over the next year, Duke hopes to engage the campus community by not only making them aware of the University's significant GHG reduction efforts but by making them an integral part of this endeavor. By creating a campus culture of sustainability Duke can reduce the university's overall environmental impact while educating the future leaders of tomorrow.

Tracking Progress

The Campus Sustainability Committee (CSC) will continue meeting every two months. For the 2009-2010 academic year, the focus will be two primary goals –

- Updates on the Climate Action Plan (CAP) to review accomplishments and measure progress
- Subcommittees will continue to work on areas that need further development and definition such as air travel guidelines, green fleet policy, renewable energy options, energy efficiency projects and local offsets development

As the CAP becomes more institutionalized the CSC will expand its focus on campus sustainability metrics beyond carbon to areas such as water, waste/recycling, land use, etc.

In recognition of the numerous external factors impacting Duke's emissions and the ever-changing technological landscape, the Climate Action Plan will be subject to annual review to assess progress and adjust the strategy as necessary given changing circumstances over time.

APPENDIX A – Duke Campus Sustainability Committee Members

Campus Sustainability Committee Members 08-09

Faculty		
William	Chameides	Dean of the Nicholas School (Co-Chair)
Amy	Abernethy	Medicine
Norm	Christensen	Nicholas
Robert	Clemen	Fuqua
Richard	Newell	Nicholas
Lincoln	Pratson	Nicholas
Jim	Salzman	Law
David	Schaad	Pratt
Jim	Siedow	Vice Provost for Research
Staff		
Tallman	Trask	Executive Vice President (Co-chair)
Tavey	Capps	Environmental Sustainability Director
John	Noonan	Associate Vice President of Facilities
Robert	Guerry	Director, Medical Center Engineering and Operations
Jane	Pleasants	Assistant Vice President of Procurement
Chuck	Catotti	Acting Director of Parking and Transportation
Jim	Wulforst	Director, Dining Services
John	Pearce	University Architect
Eddie	Hull	Director of Residential Life and Housing Services
Michael	Palmer	Assistant Vice President and Director of Community Affairs
Paul	Grantham	Assistant Vice President of Communications Services
Tim	Profeta	Director of Nicholas Institute for Environmental Policy Solutions
Charlotte	Clark	Coordinator of Student Environmental Initiatives, Student Affairs
Anne	Light	Assistant to the Executive Vice President
Students		
Carina	Barnett-Loro	President Environmental Alliance
Alex	Michalko	President Duke University Greening Initiative
Olga	Voronina	GPSC representative
Michael	LeFevre	DSG representative

APPENDIX B - Transportation

Existing Transportation Conditions

The following section summarizes the existing transportation conditions on the Duke campus. This information is intended to provide context and help shape the opportunities and challenges in developing more environmentally friendly transportation alternatives in the future.

Pedestrians

Like many campus environments, walking is a significant means of travel between campus destinations and the adjacent retail and residential neighborhoods in Durham. Students walk between residences and academic buildings, faculty and staff walk between offices and teaching locations, and many members of the community are able to walk to restaurants, shops, and other nearby services. In addition, some faculty, staff, and students commute to the campus by walking.

The most heavily used pedestrian connections include travel within campus precincts (i.e. East-East, West-West, etc.) and travel between adjacent campuses (i.e. East-Central, Central-West, etc.); however, pedestrian activity between East, Central, and West campuses is limited due to distance, topography, physical barriers, uncomfortable peak summer and winter climate conditions, and lack of clear routes between these zones. Pedestrians are unlikely to walk from East Campus to West Campus on a regular basis due to the distance.

The following are general findings regarding campus pedestrian connections[21]:

- Pedestrian connections are largely sufficient within campus precincts.
- Inter-campus connectivity is poor (i.e. East-Central, West-Central, East-West).
- Erwin Road is a barrier to internal Health System connectivity.
- Erwin Road, the Durham Freeway, West Main Street, and the railroad are barriers to Central-East Campus connectivity and connectivity between the Duke Campus and residential neighborhoods located north of the campus.
- Distances between campus and residential neighborhoods to the northwest and south of campus make walking to campus somewhat prohibitive.
- Signage and wayfinding for pedestrians is limited within and between campuses as well as to/from off-campus locations.

There are currently no Duke sponsored programs to encourage walking as a form of commuting.

Bicycling

Bicycling is an important means of transportation, primarily for students and faculty. The University's bicycle facilities vary between shared roads (in which bicyclists share the road with

[21] Adapted from the *Transportation and Infrastructure Planning Study* conducted in the summer of 2007.

vehicular traffic), exclusive on-road bicycle lanes, and multi-use paths (in which bicyclists and pedestrians share the path but general vehicular access is prohibited).

The provision of dedicated bicycle facilities in the University context is a helpful encouragement for bicyclists. It should be noted that there is a broad range of dedicated bicycle lane conditions that exist on campus: as an example, some sections of the Campus Drive lanes are clearly marked and dedicated, while in other sections the lanes are interrupted or shifted to a shared sidewalk condition. There is a similarly broad range of conditions on the off-campus trails, some of which are unpaved.

Duke currently has two programs which encourage cycling on campus: *Duke Bikes* and *Bicycle Commuting* (see *Existing Commuting Options* later in this report). The University does not currently have any formal lockers or shower facilities to support bicycle commuting in academic buildings.

With respect to Duke's bicycle connections to the community, the City of Durham completed the *Durham Comprehensive Bicycle Transportation Plan* in 2006. This plan proposes the expansion of the existing network of bicycle facilities to better connect destinations. The existing and proposed system of bicycle routes supports bicycling as a way to travel to and from the University. If the proposed facilities are constructed, it will significantly improve bicycle connectivity between campus and off-campus destinations and will encourage bicycle use by commuters.

The following summarizes existing state of bicycle connectivity.

- Bicycling is a reasonable means of transportation for travel between campuses and the surrounding communities.
- Although bicycle facilities are present and have been added to campus streets, the bike network within campus is incomplete, or needs improvement to its physical condition.
- Although Durham has been planning bicycle routes, there are a limited number of regional bicycle routes and the campus bicycle networks are currently not connected to these routes.
- Signage and wayfinding for bicycles is very limited within and between campuses as well as to/from off-campus locations.

Planned Bicycle Improvements

The City of Durham has several near-term proposed bicycle routes in their 2006 Durham Comprehensive Bicycle Transportation Plan that will greatly increase the connectivity to residential neighborhoods where Duke constituents reside. Exhibit 2 highlights the proposed bicycle links connecting to Duke's campus.

Exhibit 2 Near-Term Durham Bicycle Network Improvement Projects

Road	From	To
Anderson Street	Chapel Hill Road	Duke University Road
Chapel Hill Street	Downtown Loop	Duke University Road
Swift Avenue	Duke University Road	Main Street

Broad Street	Main Street	Guess Road
Main Street	Hillsborough Road	Corcoran Street

These routes will greatly add to the bicycle connectivity to campus and will be used by Duke constituents. It is in Duke University's best interest to aid in the development of these connections.

Parking

Parking in and around campus and the medical center is provided in numerous surface lots and parking decks scattered throughout the area. There are a total of 22,811 parking spaces on campus, 10,815 parking spaces allocated for University and 11,996 allocated for medical center use. The largest concentration of parking can be found at the Duke University Hospital's Parking Garage 2 (2,636 spaces), Parking Garage 1 (1,797) and Parking Garage 3 (1,704). The remainder of the parking spaces are spread throughout other lots and parking decks.

Some of the parking facilities are located adjacent to the buildings they support. Other parking facilities require a five to ten minute walk to reach most destinations. Additionally, some Duke transit routes support remote parking facilities by transporting people between parking facilities and their destinations. Campus transit route PR-1 provides transit support from Green Zone parking to stops along Science Drive, Circuit Drive, and Research Drive. For example, Campus transit service also supports medical center parking with five routes connecting remote parking facilities to Duke University Hospital and other health system buildings.

A large majority of the parking spaces require permits and can therefore only be used by staff, faculty, Duke students, and other University and medical center affiliates. Duke maintains an extensive permit program in order to manage the daily use of this parking.
Parking supply in the core areas of the University and Health System are very desirable and heavily used. However, when one considers the available parking at the perimeters of the University, it appears that the overall parking supply is adequate to support commuting and student parking needs.

Parking oriented to the visitors of the University and Hospital can be found in several locations. The main Hospital patient visitor parking area is in Parking Garage 2 located on the north east corner of Fulton Street and Erwin Road. Metered locations can be found adjacent to Sarah P. Duke Gardens, Nasher Museum, and adjacent to Parking Garage 4 in West Campus. Special and performing arts event parking for the Page Auditorium and Reynolds Theater is supported in Parking Garage 4. Event parking for the Nelson Music Room and Baldwin Auditorium are located in campus lots located off Buchanan Boulevard, and along Markham Avenue and on adjacent streets.

All staff, faculty, students, and other University affiliated personnel must purchase and display parking permits on their vehicles in order to park in University controlled areas with the exception of meters and attended lots. There are approximately 28,000 permits issued to

University and Hospital related staff, faculty, and students. Eligibility for parking lots is determined based on one's affiliation with the University: 1) whether you are faculty/staff or student and 2) a student living on- or off-campus. The Parking and Transportation Department issues hangtags permits. Parking Permit fees for 2008/2009 are listed in Exhibit 3.

Exhibit 3 Parking Permit Rates August 14, 2008 – August 15, 2009

Permit	Annual	Monthly
Reserved	$1,158	$96.50
Hock Garage	$750	$62.50
Premium	$750	$62.50
Medical Center Garages	$627	$52.25
Gated	$417	$34.75
Proximate (Employees)	$366	$30.50
Proximate (Graduate Students)	$274	$22.83
Remote	$ 115	$9.65
Secondary Remote	$81	$6.80
Residential	$240	$20.00

Transit

Three transit services and several transit routes are available for those traveling to, from or within the Duke University campus and the Health System complex. Duke University operates extensive transit service free for all of its constituents. The transit system consists of three major components:

- Campus transit routes
- Parking/Satellite transit routes
- Off-Campus routes

Campus Routes

Exhibit 4 provides details regarding existing Campus transit routes. The exhibit presents the key connections that are made by each route and the frequency of the route during various time periods. The frequencies shown represent weekday academic year service. Shuttle routes C1 and C4 also provide weekend service. Summer service is provided by a single, consolidated route.

Exhibit 4 Campus Transit Routes

Route	Serves	Frequency
C1	E⇨W; W⇨E	3-5 min (Day) 10 min (Eve)
C2	E⇨C⇨W; W⇨C⇨E	10 min (Day)
C3	E⇨W; W⇨C⇨E	15 min (Day)
C4	W⇨C; C⇨W	15 min (Night)

C5	W⇨C; C⇨E; Brightleaf	20 min
C6	E⇨C⇨W; W⇨C⇨E	30 min

The main East-West campus connector route, Route C1, has an annual ridership of almost 1.3 million riders. This is more than twice the ridership of any other transit route run by Duke. The C1 Route runs at a frequency of 3-5 minutes during peak academic hours and travels between East Campus and West Campus with several stops along Campus Drive.

Route C2 and C3 routes also connect East and West Campuses but wind their way through Central Campus and have significantly more stops than the C1 route. Route C4 runs exclusively at night and provides service between West Campus and Central Campus.

Route C5 provides connections between West Campus, Central Campus, 9th Street retail area, and the Brightleaf Square area between 7:00 PM and 3:00 AM, Thursday through Saturday during the academic year. The Erwin-Mill Shuttle, also known as C6 provides service during the day between West Campus and East Campus and will stop at the Erwin-Mill Building.

Parking/Satellite Office Shuttles

Exhibit 5 presents the dedicated shuttle routes that service parking areas on and off-campus. The frequency shown in the exhibit represents year round service. These parking transit routes only operate on weekdays and primarily serve Duke University Heath System employees.

Exhibit 5 Parking/Satellite Office Shuttles

Route	Serves	Frequency
PR1	Stadium/ W. Campus	10 min (Peak Periods) 20 min (Midday)
H1	PG3	7 min (Peak Periods)20 min (Midday)
H2	PG3	10 min (Peak Periods only)
H3	Hillsborough H Lots	7 min (Peak Periods) 20 min (Midday)
H5	Hock, DUMC, Wachovia, Mill	15 min
H6	LaSalle Street Overflow Lot	10 min (Peak Periods) 20 min (Midday)

Parking shuttles generally run at a frequency of 10 minutes during peak hours and 20 minutes during off-peak hours. The H3 and H6 routes, that provide service to the H permit lots, have the highest annual ridership with approximately 550,000 riders per year.

Off-Campus Transit Routes

Duke University Parking and Transportation provides two shuttle routes to off-campus destinations: The Robertson Scholars bus and the LaSalle Loop. The Robertson Scholars bus provides non-stop service between Duke and the University of North Carolina at Chapel Hill in support of a joint academic program. This bus is free to all UNC-CH and Duke University students, faculty and employees and operates at a 30 minute frequency during peak weekday hours and at a 60 minute frequency all other times.

The LaSalle Loop route provides connections between Duke University's West and Medical Campuses and residential neighborhoods located northwest of the campus. This bus operates at a 30 minute frequency Monday through Friday. In its first four months of service, from September to December of 2008, the route carried an average of 550 passengers a day. It is anticipated that this will increase as more Duke Community members realize that this residential area is supported by convenient transit service.

Triangle Transit Authority

The Triangle Transit Authority (TTA) provides regional bus service throughout the greater Triangle Region, including Raleigh, Durham, Cary, Garner, Apex, Hillsborough, Chapel Hill, and the Research Triangle Park (RTP). There are three main hub transfer stations operated by the TTA to provide connections to local transit services and other TTA routes. These main transfer points are located in Durham, the RTP, and at Moore Square in Raleigh. The frequency of routes varies but all routes generally run with a limited number of stops. TTA also provides rideshare service and regional transit planning. Recent system planning studies recommended investment in a multi-modal transit center in downtown Durham as well as a regional rail system. The regional rail service is currently in a state of uncertainty while the TTA reevaluates its vision and capital program.

The TTA bus service makes stops along the periphery of Duke University's campus, generally servicing the Health System buildings via the two routes highlighted in Exhibit 6. TTA buses will also stop if flagged down at Durham Area Transit Authority (DATA) stops (described below). Bus frequencies for the two TTA routes that service Duke's campus are 30 minutes during peak hours and 120 minutes during off-peak hours. Due to the regional nature of the TTA routes, 30 minute frequencies are reasonable; however the 120 minute off-peak service limits its potential to meet the needs of many Duke constituents traveling during these periods. Ridership numbers for TTA routes were researched but unavailable.

Exhibit 6 TTA-Duke Routes

Route	Serves	Frequency
412/413	DUMC and Downtown	30 min (peak) 120 min (off-peak)

402/403	DUMC and Downtown	30 min (peak) 120 min (off-peak)

Durham Area Transit Authority

The Durham Area Transit Authority (DATA) provides bus transit service throughout the greater Durham area. Two bus routes, Route 6 and Route 11, service Duke providing access to Downtown Durham and points west (see Exhibit 7). Route 6 runs alternating spurs; one spur forms a loop on the Dukes Campus along Science Drive and Cameron Boulevard; the second spur serves local neighborhoods north of 15/501. DATA bus frequency in the area is 30 minutes throughout the day (from 5:30 AM to 12:30 AM; 6:30 AM to 7:30 PM Sundays). For the local bus service, these headways generally lower the potential ridership.

Exhibit 7 DATA-Duke Routes

Route	Serves	Frequency
DATA 6	Duke University and VA Hospital	30 min
DATA 11	Duke University and Hillsborough Road	30 min

Duke offers discounted local and regional bus pass (see *Commute Options*).

Planned DATA Improvements

DATA recently made available its 2010-2015 Short Range Transit Plan which includes several new transit routes connecting to Duke. These routes are outlined in Exhibit 8.

Exhibit 8 New DATA Transit Routes

			Duke constituents living within	
Route	Headway (min)	Start Date	0.25 miles of Route	0.50 miles of Route
Downtown to Duke Circulator	10/15/30	2010	265	670
Southpoint Mall to Duke Health System	30/60	2010	757	1,062
Durham Regional Hospital to Duke Health System	30/30	2011	358	928
Duke to South Square	15/30	2014	258	596
Totals			1,638	3,256

Many Duke employees and students live in neighborhoods within a short distance to these new routes. It is anticipated that these new routes will result in additional shifts to transit mode share.

Existing Commute Options

Rideshare (2 per vehicle)

Parking and Transportation implemented a rideshare program which aims to reduce single occupant vehicles (SOV) arriving to campus on a regular basis. A Duke community member can partner with another Duke community member to arrive to campus together in a single vehicle and share a single parking permit. In addition to sharing the cost of the parking permit, each participating individual receives 24 day passes (12 passes for the preferred lot and 12 for any remote lot) to use when they must drive alone. In addition, rideshare permit assignments are given priority over individuals who drive alone.

Carpooling (3+ per vehicle)

Through Parking and Transportation Services, the University community may participate in carpooling. Carpooling reduces the number of single occupant vehicles on campus and can provide significant cost savings for participants. According to the Parking and Transportation, a carpool is defined as three or more employees or students arriving to campus together in the same vehicle. Through its website partner Greenride, Duke University community members can register and find a carpool with others living in the same area. Once a carpool is formed, carpools with 4 or more staff/faculty or graduate student members receive a free carpool parking permit to a preferred lot and each individual receives 12 daily passes for access to your group's preferred lot and 12 for any remote lot should they need to drive to campus alone. Three-person carpools pay $4 per month per person and receive a single carpool permit to a preferred lot and the same daily pass accommodations as a 4+ member carpool. Carpools of four or more undergraduate students receive a free parking permit to a preferred reserved location in the Blue Zone parking area and 20 day passes for unreserved spaces in the Blue Zone. Three-person undergraduate carpool members pay $40 per person annually and receive the same benefits as a 4-person carpool.

Carpoolers are not permitted to retain their individual parking pass. In addition, the Parking and Transportation Services provides a web page that calculates anticipated cost savings for potential carpool participants.

Vanpooling

TTA's Vanpool program provides a cost-effective commuting option. Vanpools are typically made up of seven to 15 commuters who all divide the cost of the van, maintenance, repairs, and insurance. The vanpool contains one primary driver/coordinator who volunteers to organize the vanpool. As an added benefit, this coordinator is able to utilize the van for personal use during nights and weekends at no additional cost. Typically, commuters of a vanpool meet in one designated location or may make several stops to pick up commuters. TTA has run out of vans available for vanpools but is working to acquire more.

Duke provides additional provisions for vanpool participants. TTA vanpools are allowed access to any Duke University unreserved parking area without a permit and each Duke University vanpool participant each receives 12 daily passes for access to the group's preferred lot and 12

for any remote lot should they need to drive to campus alone (additional day passes can be purchased for $3 each.

Bicycle/Walking

Employees and students within bicycling/walking distance of the University are accommodated via bicycle-friendly public transit services and some off-campus infrastructure including bicycle paths, sidewalks and trails. Some Duke University Transit, DATA, and TTA buses provide bicycle racks on vehicles. The Bicycle and Pedestrian Advisory Commission of Durham provides cycling and walking information including web-based maps of existing bicycle accommodations and bicycle racks throughout Durham. Duke University currently sponsors two bicycle programs.

- *Duke Bikes* - Duke Bikes is a bicycle-loan program sponsored by the University which allows students to borrow bicycles free of charge for five days. Started during late summer of 2007, the program's goals are to promote alternative forms of transportation, build community, and promote campus health. Approximately two months after the program started, Duke Bikes had 481 members and had approximately 100 bikes checked out per day. One quarter of the Duke Bike members live off-campus. While Duke Bikes can be used for commuting purposes, it is targeted at recreational, intra-campus travel and periodic use. At the time of this report, 2008 data was not available for Duke Bikes.
- *Bicycle Commuting Program* - Duke University Parking and Transportation Services sponsors the Bicycle Commuting Program which provides registered bicycle commuters 24 daily parking passes free of charge (12 for a preferred lot and 12 for a remote lot; additional passes can be purchased for $3 each). This program is offered to students and employees. Participants in this program must commit to not purchase a Duke University parking permit.

Duke University does not currently have formal walk commuting programs or lockers or shower facilities in academic buildings specifically for bicycle or walk commuters.

Flexible Work Options

When appropriate and approved by a supervisor, the University permits its employees the opportunity to participate in several flexible work options. These options include the following:

- Flextime
- Telecommuting
- Compressed Week
- Job Sharing
- Abbreviated Schedule/Part-Time
- 10- or 9-Month Arrangements

More emphasis in this area, if workable from an operational standpoint, would have a very positive effect on emissions.

Guaranteed Ride Home Program

University commuters that utilize modes of transportation other than single occupancy vehicles and are registered in the program are eligible for TTA's Guaranteed Ride Home program.

Participants register for the program and receive a taxi or rental voucher and directions on how to use the voucher. In the event of an emergency or a request to stay late at work, members receive transportation service and must provide the voucher to the taxi or rental car upon arrival. The program funds one emergency related trip. Eligible commuters include the following: carpoolers, vanpoolers, public transit users, walkers, and cyclists.

Zipcar

Duke University participates in a car sharing program called Zipcar. Zipcar provides Duke University members with a convenient, short-term car rental access. For an annual membership fee of $35, participants pay $8 per hour or $66 per day to use the vehicle. The initial student membership fee is applied as a credit toward reservations after membership is confirmed. Duke University currently has four Zipcars located on West Campus and two on East Campus.

Discount City and Regional Bus Passes

As of 2008, Duke Parking and Transportation Services currently offers discount city and regional bus passes at a savings of up to 60 percent. Exhibit 10 provides the discounted transit rates University members can participate in.

Exhibit 10 Discounted Transit Pass Rates

Service	Regular Rate[1]	Occasional Rate Use[2]	Frequent User Rate[3]
DATA 20-trip	$16	$8	Not available
DATA 30-day	$36	$18	$12
Triangle Transit Regional 20-trip	$32	$16	Not available
Triangle Transit Regional 30-day	$64	$32	$24
Triangle Transit Regional 30-day express	$80	$40	$32

1 No Duke University Discount
2 Purchase through Parking and Transportation Services (no payroll or bursar deduction)
3 Payroll deduction or bursar account with automatic renewal

Existing Fleet Vehicles

Duke University owns 641 vehicles that contribute to the overall transportation-related GHG emissions. Exhibit 11 provides the different fleet vehicle types that operate at Duke.

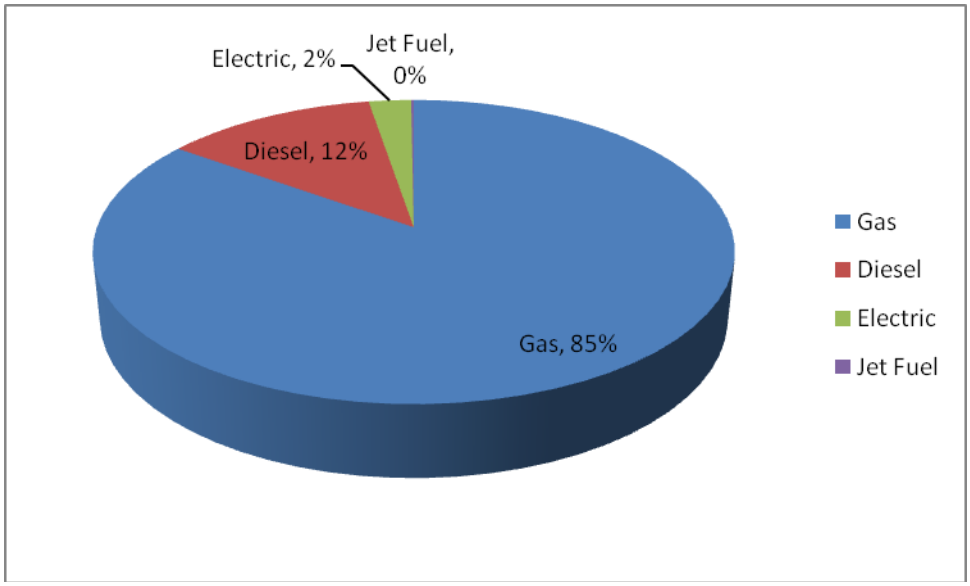
Exhibit 11 Fleet Vehicle Type

Type	Number of Vehicles
Ambulance	7
Bus	39
Cargo Van	120
Cushman	1
Dump Truck	1
Golf Cart	4
Helicopter	1
Passenger Van	106
Sanitation Truck	1

Sedan	77
Small Truck	10
SUV	62
Three Wheel Mobility	2
Truck	207
Wagon	3
	641

These vehicles use different types of fuel. Exhibit 12 presents the fuel mix of the fleet.

Exhibit 12 Fleet Fuel Mix



The age of these vehicles and the operating condition varies significantly which in turn affects their fuel efficiency and the statement that their use makes to the broader Duke community. The average age of the campus fleet is approximately 9.5 years. Exhibit 13 provides the relative age of the campus fleet.

Exhibit 13 Fleet Age

Age (Years)	Number of Vehicles
0-5	174
6-10	213
11-15	164
16-20	68
>20	22
	641

The University is currently undergoing a separate study that is investigating the right-sizing and greening of its non-transit related fleet.

Identification of GHG Reduction Options

Based on the input from the Duke University GHG Transportation Sub-committee, the Duke Transportation Advisory Committee and research conducted on peer institutions, several potential GHG reduction options were identified and reviewed in a cursory fashion to understand how effectively they would operate in the Duke University setting. These alternatives were grouped by the three largest contributors to transportation related greenhouse gases: commuters, air travel, and fleet vehicle use.

Commuter Options

The following programs target commuter related activity and their respective greenhouse gas emissions.

Transportation Coordinator

A transportation coordinator is essential to coordinate changes with local and regional transportation authorities, assist commuters with their options, conduct program marketing and develop websites, and program assessment.

Program Marketing

Frequent communications, including email newsletters, articles in student and faculty newspapers, print advertisements, banners, and involvement in University events would help increase the recognition and benefits of alternative commuting.

Website Enhancements

The Duke University Parking and Transportation website would present clear, concise format for the displaying different commuting options. Attention would be given to the various resources available to help people make decisions and the ecological and economic benefits of non-single occupancy vehicle commutes.

Parking Price Increase

An aggressive pricing approach would help the University decrease the number of single-occupancy vehicles that travel to campus. The scenario includes varying initial and incremental increases thereafter to reinforce use of alternatives to driving. It is expected that a range of permit prices would continue to be available and that pricing for each category would be adjusted to continue to provide a market-driven balance of supply and demand for the various permit categories.

Parking Permit Buyback

A permit buyback program would reward current parking permit holders for surrendering their parking permit and choosing an alternative commute- be it rideshare, transit, cycling, or walking. The issue of benefits to employees who do not currently hold a permit may or may not need to be addressed. Additionally, the program could be implemented with a grace-period, so that the employee can transition into other modes, improving their comfort with accepting the buyback.

Rideshare/Vanpool/Carpool Parking Location
Reserved parking spaces in premium lots would be provided adjacent to handicapped ones for the convenience of rideshare commuters. This benefit is a common strategy to make ridesharing/carpooling/vanpooling more appealing.

Rideshare/Vanpool/Carpool Financial Incentives
The University would reward all rideshare participants by giving them a free parking permit on campus. A more aggressive approach to increasing rideshare participation would be to offer a financial incentive to get commuters to participate in shared-ride programs. The University would offer a stipend in the range of $100 – 200 annually, to commuters who take van/carpools to campus. The program could have varied bonus depending on how many people are in the van/carpool and which lot is selected. A perimeter lot might get a larger stipend than a central, premium lot.

Housing Incentives
The University would become involved with the creation or financing of housing within walking, bicycling or transit access of campus. This incentive would encourage faculty and staff to overcome barriers preventing them from living within walking or bicycling distance from the campus such as the need to renovate property.

Cycling Improvements (pathways, intersections, showers, racks)
The University would address concerns about traffic and bicycle conflicts at certain intersections near campus. Bike lanes and paths would be constructed on- and off-road. These improvements would help improve the safety and convenience of commuting by bicycle. At the less aggressive end of the range, bicycle amenities, like secured storage and access to shower facilities also would aid bicycle commuters. The University would also work with the City of Durham to implement bicycle accommodations to connect regional bicycle route with campus routes. In addition, the University may work with the City of Durham to find financing for these improvements.

Pedestrian Improvements (sidewalks, signal priority, street trees, etc.)
Improvements to the pedestrian environment would be implemented aggressively. These improvements are essential to getting more commuters to consider walking a viable alternative to driving to and within campus. Wide, continuous sidewalks provide room and safety to walkers, while improved crosswalks and crossing signals would help reduce vehicle conflicts. Other features, like additional street trees, add shade and visual appeal to streetscapes.

Discounted/Free-Ride Transit
The University would maintain its arrangement subsidize employees' fares on the local and regional transit systems. A more aggressive approach would be to fully subsidize transit costs for participants.

Commuter Membership Program

An alternative commuter program would be created, so the University can track participation, commuting behavior, and market program updates. The program could provide rewards, prize drawings, and refer-a-friend bonuses to help increase participation. A financial reward, of approximately $150 annually would be provided for people who commute to campus by bicycle or walking. This reward could either be a direct cash reward, or could be provided through an outside service provider through a sponsored reward program. For an example of this type of program, visit www.nuride.com.

Member Spot-Rewards
Providing spot rewards as overall transportation milestones are achieved would help maintain interest in alternative commuting and possibly lure new participants while encouraging the University community to work together on achieving mode split or parking goals.

Transportation Events
University events, like employee and new student orientations provide great forums to communicate commuting options before people have already developed a travel pattern. The transportation manager would emphasize the cost savings and ecological benefits of alternative commutes, while providing guidance to individuals wondering what the most appropriate option is for them.

Transit Advocacy/Coordination
The University would continue to assess commuters' satisfaction with the DATA and TTA and suggest route changes to serve University commuters. The University would also advocate for improved funding and service for these agencies.

Park & Ride Implementation
Regional park and ride lots have varying popularity and almost all existing park and ride lots do not have supporting transit routes to campus. There is an interest in exploring the use of park and ride lots and providing transit service to campus to support their use. DATA is planning to implement several new transit bus routes connecting to the University. The University would survey its commuters to determine the best locations for park and ride lots and coordinate with DATA and/or TTA to provide service to campus from there.

Pre-tax payment for Alternatives
Alternative transportation expenses- rideshare parking permits, vanpool fuel and fees, etc., would be payable by employees on pre-tax, payroll basis.

Alternative Transportation Marketing
The University, TTA, and other regional organizations offer a variety of alternative commuter services that would be useful for University employees. The University could aggressively market the programs available through the regional organizations and through Duke University Parking and Transportation Services.

Ride Matching Assistance
A key function of the transportation coordinator's position should be to help commuters find appropriate ride share partners. There are several regional rideshare databases including the GreenRide program to which Duke University subscribes. The University's transportation coordinator could help their efforts by providing supplemental service and more personalized attention to aid Duke participants to find rides that are convenient.

Occasional Parking Program
An occasional parking program provides an option for alternative commuters to take their personal vehicle to campus, a few times a month or so, when their non-single occupancy vehicle commute is not convenient for them. Certain lots and rates would continue to be designated to accommodate these parkers.

Financial and preferential parking incentives for fuel efficient vehicles
Reimbursement or voucher toward purchasing a fuel efficient car – typically a hybrid or another type of vehicle which gets a pre-determined rate of fuel efficiency for city driving. In addition, fuel efficient cars could get preferential parking – choice of preferred parking location. Program members could need to live a certain distance from campus to make this worthwhile from a reduction standpoint and not encourage existing walkers, etc. from switching modes

Air Travel Options
An intitial brainstorming of ideas and options for reducing air travel, as well as a literature search of what other colleges and universities are implementing to manage air travel emissions, produced an initial list of candidate options for consideration:

Policy Options

- Travel caps or reduction goals based on past air travel budgets
- Travel procurement guidelines to minimize air travel impacts
- Minimum flight distance/maximum drive distance requirements
- Mandatory carbon offsets linked to department usage

Promotional or Operational Options

- Train use promotion/partnerships
- Promotion or availability of "Smartway" or "Smartway Elite" car loaner program
- Rewards/incentives like gift certificates for carpooling to/from regional conferences
- Cooperative programs /partnerships among research institutions and/or the Research Triangle Park area for ridesharing or bus charters to conferences or special events
- Taxi vouchers to the train or bus stations

Infrastructure Options

- Tele-conference/ video-conference facilities
- Media center / outlets for on-line collaboration

Fleet Options
Options that were identified to reduce campus fleet-related emissions include:

- "Greening" the existing service and administrative fleet
    - Operating existing fleet on low-emission fuel
    - Right-sizing overall service fleet
    - Replacing a portion of the service fleet with:
        - Electric gators
        - Hybrid vehicles
        - Bicycles
- Replacement of on-campus transit vehicles with:
    - Hybrid vehicles
    - Ethanol
    - CNG
    - Or the "Next Big Thing" in technology
- Elimination of inefficient transit routes or modification of service vehicle types

Analysis of GHG Options
This chapter of the report presents the analysis of GHG emission options by the principal transportation segments: Commuter, Air Travel, and Fleet. The analysis methodology is described and detailed by its components. The final section of the chapter presents the overall program results.

External Factors
There a number of external trends, beyond the control of Duke University, that will influence transportation emissions in the future. These externalities principally relate to the production of cleaner vehicles over time (Corporate Average Fleet Economy or CAFE standards), innovations in aircraft technologies resulting in more fuel efficient aircraft, and improvements in air traffic control and airside operations reducing extra miles traveled due to circling or landing delays.

A significant percentage reduction in commuter and fleet related emissions are expected to result from improvements in vehicle fuel efficiency. The Energy Independence and Security Act (P.L. 110-140, H.R. 6) passed into law in 2007 increases the CAFE standards to 35 miles per gallon, or about 40 percent, by 2020[22]. It is reasonable to believe that these fuel efficiency standards will increase by at least an additional 20 percent by the year 2050. A 60 percent increase in fuel efficiency over existing standards is still below standards already established in

[22] *CRS Report for Congress: Energy Independence and Security Act of 2007: A Summary of Major Provisions*, December 21, 2007

Japan and Europe for the year 2020[23]. The rate by which commuters replace their private vehicles is beyond the control of Duke but can reasonably be expected to track with trends in the CAFE standards; however, the rate by which Duke "greens" its own fleet to meet or exceed CAFE standards is entirely within Duke's control, as discussed in a subsequent section of this chapter, and will be realized by Duke's own policy and investment strategies.

Recent research in the airlines industry has forecasted an increase in aircraft fuel efficiency on the order of 25% by 2020 and air traffic management enhancements of 12 percent by 2020. Independent of demand management or policy measures implemented by Duke, these factors will measurably decrease the emissions associated with air travel in the future.

External reductions in commuter emissions due to expected fuel efficiency gains and technological and operational improvements in the airlines industry are factored in to the "Business as Usual" wedge analysis presented in the next chapter of this report.

Commuter Program Evaluation

A comprehensive Transportation Demand Management (TDM) plan for Duke University is a strategic plan providing recommendations for the transportation system improvements over time. A plan of this type requires examining the future of campus from both a physical and user perspective, and recommending tools and mechanisms to better link transportation and land uses to affect a more efficient and sustainable transportation system.

A successful TDM plan is:

- Comprehensive;
- Supportive of University vision and policies;
- Tailored for different land uses and user groups;
- Coupled with parking management;
- Encourages investment in and use of alternative modes;
- Reinforced by physical design elements; and
- Periodically monitored and modified.

The University currently supports alternative modes to the single occupant vehicle, but there are challenges to modifying travel behavior. Shifts to alternative modes are often not realized due to the availability of convenient, reasonably priced parking, a lack of alternatives, schedules or family constraints that require a car, a lack of awareness about alternatives, or inadequate incentives or deterrents to driving alone.

TDM program effectiveness can vary significantly based on the destination, demographics of the commuters, and the level of commitment to program by the institution. A Duke TDM program would focus on commuters to campus and the health system. The following exhibit

[23] Technology Review, *The New CAFE Standards: Fuel standards will likely be achievable but won't encourage innovation,* Peter Fairley, January 15, 2008.

presents the ranges of effectiveness the above commuter programs generally provide. Not all programs have quantifiable reductions in mode use shifts.

Exhibit 15 Estimated Potential TDM Program Trip Reductions

Program Element	Potential Trip Reduction
Parking Price Increase	1-10%
Parking Permit Buyback	1-4%
Vanpool/Carpool Parking Location	1-4%
Vanpool/Carpool Financial Incentive	1-3%
Housing Incentives/Sponsorship	Unknown
Bicycling Improvements	1-8%
Pedestrian Improvements	1-3%
Fare-Free Transit[2]	0-3%
Commuter Membership Program	1-3%
Transit Advocacy/Coordination	Unknown
Park & Ride Implementation	Varies
Pre-Tax Payment for Alternatives	<1%
Program Marketing – Website Enhancements, Transportation Events, Member Spot-Rewards	1-4%
Ride Matching Assistance	1-4%
Car Sharing	1-4%
Flexible Work Arrangements	1-4%
Occasional Parking	1-4%
Transportation Coordinator	1-4%

The United States Environmental Protection Agency's (EPA) Commuter Model (version 2.0) was used to test the effectiveness of the various TDM program options. The Commuter Model is a spreadsheet-based computer model that estimates the travel impacts of TDM programs. Using the Commuter Model, several financial incentive packages were analyzed. The program considers the impact of many different types of programs on travel behavior, such as:

- Transit fare incentives;
- Transit service improvements;
- Ridesharing programs including financial incentives and preferential parking;
- Parking pricing;
- Pedestrian and bicycle improvements; and
- Flexible work arrangements.

The model allows the analyst to consider the impact on mode share and parking demand from a variety of scenarios using a LOGIT mode-choice methodology, commonly employed by more complex regional travel demand models. Several assumptions were employed in this analysis including:

- Existing Journey-to-Work mode split data for Duke University and Health System;
- Population for faculty, staff, and students;
- Parking supply and permit information provided by Parking and Transportation;

- Address information for employees and graduate students;
- A mid-size City (Santa Cruz, CA) city characteristics (one option available in the Commuter Model); and
- Numerous model-default travel characteristics such as: work trip length, peak period duration, percent of trips during the peak period, etc.

With the above assumptions and information held constant, inputs reflecting the TDM programs were employed in the model. The results of the model for each TDM Scenario are presented in the following exhibit.

Parking Pricing

Duke employs a range of parking permit prices for its parkers based primarily on the location of the parking facilities. Based on information from permit sales, the approximate average monthly price to park at Duke is $26. Using the Commuter Model, several parking price increases were reviewed to see how parking pricing affects mode share.

Exhibit 16 Parking Pricing Increase Mode Share Shift

Mode	Baseline $26/month	25% increase $32.50/month	33% increase $34.58/month	50% increase $39/month	100% increase $52/month	150% increase $65/month
Drive Alone	77.0%	76.4%	76.2%	75.8%	74.3%	72.4%
Carpool	10.0%	10.3%	10.3%	10.5%	11.2%	12.0%
Vanpool	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Transit	3.0%	3.1%	3.1%	3.2%	3.4%	3.6%
Bicycle	5.0%	5.1%	5.2%	5.3%	5.6%	6.0%
Pedestrian	4.0%	4.1%	4.1%	4.2%	4.5%	4.8%
Other	1.0%	1.0%	1.0%	1.1%	1.1%	1.2%
	100%	100%	100%	100%	100%	100%
MTeCO2	52,496	52,254	52,129	51,980	51,339	50,479
Difference		242	367	516	1,157	2,017
% MTeCO2 Reduced		0.5%	0.7%	1.0%	2.2%	3.8%

Transit Cost Reductions

Duke currently offers significant discounts in transit fare to its constituents. While these discounts provide significant savings, there is an opportunity to provide deeper discounts to participants. Using the Commuter Model, several transit cost reductions were reviewed to see how cost could potentially affect mode share. It is important to note that the mode split changes below represent reductions of the most expensive renewable transit pass available, the Triangle Transit Express 30-day pass.

Exhibit 17 Transit Cost Reduction Mode Share Shift

Mode	Baseline $32/month	25% reduction $24/month	50% reduction $16/month	100% reduction $0/month
Drive Alone	77.0%	76.7%	76.3%	75.5%
Carpool	10.0%	10.0%	9.9%	9.8%

Vanpool	0.0%	0.0%	0.0%	0.0%
Transit	3.0%	3.4%	3.8%	4.8%
Bicycle	5.0%	5.0%	5.0%	4.9%
Pedestrian	4.0%	4.0%	4.0%	3.9%
Other	1.0%	1.0%	1.0%	1.0%
	100%	100%	100%	100%
MTeCO2	52,496	52,466	52,341	52,203
Difference		30	155	293
% MTeCO2 Reduced		0.1%	0.3%	0.6%

Carpool Financial Incentives

Duke University currently offers several levels of incentives for carpool participants depending on the number of participants in each carpool. In addition to these incentives, additional monetary incentives could be provided to increase participation. The Commuter Model was used to calculate how a stipend for carpool participants would affect the overall mode split. The following exhibit presents various stipend levels (between $100 and $200 annually) and their affect on mode split.

Exhibit 18 Carpool Financial Incentive Mode Share Shift

Annual Stipend	Baseline	$100	$125	$150	$175	$200
Drive Alone	77.0%	75.7%	75.3%	75.0%	74.6%	74.2%
Carpool	10.0%	11.5%	11.9%	12.4%	12.8%	13.2%
Vanpool	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Transit	3.0%	2.9%	2.9%	2.9%	2.9%	2.9%
Bicycle	5.0%	4.9%	4.9%	4.9%	4.8%	4.8%
Pedestrian	4.0%	3.9%	3.9%	3.9%	3.9%	3.9%
Other	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
	100%	100%	100%	100%	100%	100%
MTeCO2	52,496	52,112	51,987	51,956	51,831	51,706
Difference		384	509	540	665	790
% MTeCO2 Reduced		0.7%	1.0%	1.0%	1.3%	1.5%

Park and Ride Evaluation

Separate from the Commuter Model, the potential to intercept parkers at regional park and ride sites was also analyzed. Development of a park and ride program creates an opportunity to reduce single occupancy vehicle arriving to campus thus reducing the number of on-campus parking spaces required. By bringing commuters to a single location, focused transit service can provide commuters with access to the campus. Four park and ride lots, each located adjacent to major regional roadways, were evaluated to understand how many Duke constituents would

be able to be intercepted and consequently what reductions in GHG emissions might be realized.

It was assumed that each potential park and ride location will be serviced by existing or proposed local or regional transit services. Using geo-coded employee home addresses, capture areas were generated based on their proximity to regional roadways and their location relative to the park and ride locations. Exhibit 19 provides the locations of the park and rides, their respective commuter sheds, and the distance from each park and ride to the center of campus.

Exhibit 19 Number of Park and Ride Participants

			Potential Population by Percent Capture Rate					
Park and Ride (P&R)	Potential Capture Population	Distance from P&R to Duke Campus	1%	5%	10%	15%	20%	25%
TTA Transit Center/Page Rd	3,447	9.8	34	172	345	517	689	862
South Square Target	1,222	2.9	12	61	122	183	244	306
NC751 and US70	1,871	3.6	19	94	187	281	374	468
Durham County Stadium	3,551	3.5	36	178	355	533	710	888

The associated reductions in GHG emissions are provided in Exhibit 20.

Exhibit 20 Park and Ride MTeCO2 Reductions

	Percent Capture Rate of Potential Population					
Reductions in MTeCO2						
Park and Ride	1%	5%	10%	15%	20%	25%
A	68	342	684	1025	1367	1709
B	7	36	72	109	145	181
C	14	68	136	204	272	340
D	25	125	250	374	499	624
Total	114	571	1,142	1,713	2,283	2,854
Potential P&R Transit Emissions						
A	43	215	430	645	860	1,075
B	5	23	46	68	91	114
C	9	43	86	128	171	214
D	16	78	157	235	314	392
Total	72	359	718	1,077	1,436	1,794
Net Reductions (MTeCO2)	**42**	**212**	**424**	**636**	**848**	**1,060**
% MTeCO2 Reduced	0.1%	0.4%	0.8%	1.2%	1.6%	2.0%

Composite TDM Plan Results

Based on the input from the Duke GHG Transportation Subcommittee, Duke Transportation Advisory Committee, and the analysis presented above, the following commuting mitigation strategy has been developed:

- Baseline Scenario;
- Near-Term Scenario;
- Mid-Term Scenario; and
- Long-Term Scenario;

The TDM scenarios are focused on commuters to campus and the Health System. They do not focus on measures intended to reduce student-resident driving. The first scenario (Baseline) is resented to illustrate conditions without expansion of the University's TDM program. The subsequent scenarios include additional or more aggressive implementation of the TDM measures. The elements of the scenarios are summarized in Exhibit 21. Exhibit 21 also notes those cases where the measures are implemented to a different degree. For example, ranges of parking price increase are indicated in the first row of the table. Rows that include a diamond symbol indicate implementation of a program that does not have an easily identifiable range of variability.

Although particular measures are included in each of the TDM scenarios, it is important to recognize that the degree of commitment to TDM indicated by the scenario is a more important determinant of success than the specific combination of programs. Also, some programs have a higher direct impact on travel behavior (e.g. parking pricing) while others support people's understanding of and willingness to use alternatives (e.g. TDM marketing program). A robust combination of these types of measures will provide the most effective program.

Exhibit 21 TDM Scenarios

		TDM Scenario		
		Near-Term	Mid-Term	Long-Term
TDM Measure	**Baseline**	**<5 years**	**5-10 years**	**>10 years**
Parking Price Increase	Minor	20 – 33 %	50 %	100 %+
Parking Permit Buyback				◆
Student Parking Reduction[1]				◆
Vanpool/Carpool Parking Location	Reserved	Reserved	Reserved	Premium
Vanpool/Carpool Financial Incentive	Discount	Discount	Discount	Free & Bonus
Housing Incentives/Sponsorship				◆
Bicycling Improvements			Racks, etc.	Lanes/Paths
Pedestrian Improvements				◆
Discount/Free Transit	Discount	Free	Free	Free
Commuter Membership Program				◆
Member Spot-Rewards				◆
Transportation Events				◆
Transit Advocacy/Coordination	◆	◆	◆	◆
Park & Ride Implementation		◆	◆	◆
Pre-Tax Payment for Alternatives	◆	◆	◆	◆
Program Marketing		◆	◆	◆
Ride Matching Assistance	◆	◆	◆	◆
Car-Sharing	◆	◆	◆	◆
Flexible Work Arrangements				◆
Occasional Parking	◆	◆	◆	◆
Transportation Coordinator		◆	◆	◆
Program Marketing		◆	◆	◆
Website Enhancements		◆	◆	◆

1. Student changes are not modeled; however an aggressive program could include changes to student parking policies and other measures to reduce automobile use by students.

◆ Program element included. Where appropriate, a level of program implementation is identified.

Using the Commuter Model, these TDM mitigation scenarios were tested to determine their overall effect on mode shares and reductions in GHG emissions as presented in Exhibit 22.

Exhibit 22 Commuter Mode Share Shift

Mode	Baseline	Near-Term <5 years	Mid-Term 5-10 years	Long-Term >10 years
Drive Alone	77.0%	72.1%	70.7%	61.5%
Carpool	10.0%	11.9%	12.1%	16.7%
Vanpool	0.0%	1.7%	2.5%	4.7%
Transit	3.0%	4.2%	4.6%	7.7%
Bicycle	5.0%	5.2%	5.1%	5.0%
Pedestrian	4.0%	4.0%	4.0%	3.6%
Other	1.0%	1.0%	1.0%	1.0%
	100%	100%	100%	100%
MTeCO2	52,496	51,028	50,622	48,244
Difference		1,468	1,874	4,252
% MTeCO2 Reduced		2.8%	3.6%	8.1%

In addition to the commuter targeted strategies evaluated using the Commuter Mode Share, it is anticipated that the introduction of local DATA transit routes to the residential neighborhoods adjacent to Duke can shift single occupant vehicle use to transit use by 1 to 3 percent, yielding an additional reduction of 1 to 2 percent of commuter-related GHG emissions and the participation in a Park and Ride program, if coupled with aggressive permit and parking management, has the potential to reduce commuter -related GHG emissions by 1 to 3 percent. All told, long-term commuter related GHG reductions will reduce by 10 to 15 percent.

Air Travel Evaluation

The analysis of air travel related options was premised on three areas of investigation: a review of air travel reduction strategies being implemented in similar settings; an analysis of substitutable, and more environmentally benign transport modes for common Duke destinations; and input from Duke constituents.

Review of Practices

There was an extensive range of policies and mechanisms being used to influence air travel usage uncovered through research of documented practices at other institutions, but none found that dictated reductions in air travel demands based on prior inventories of use.

The most commonly adopted strategies can generally be categorized as educational and policy-related actions to change the context in which people make travel decisions with the ultimate goal to make these decisions more rational and environmentally conscientious. One helpful trend that may have more positive impacts than any isolated policy action, in terms of air travel demand reductions, is that many institutions and professional associations are going through the same process of greening themselves. This is leading to a collective awakening to the negative effects of air travel emissions and a self-governing to reduce discretionary travel

and/or to migrate toward a broader program of on-line training, meetings, and increased reliance on video conferencing.

A second family of actions being used widely to manage air and regional travel demands is the promotion of video conferencing and web meeting resources through investment in technology infrastructure or operational programs. These include both strategies to improve access to conference facilities and educational/promotional efforts to increase their use.

Many colleges and universities are accepting the need for air travel and simply electing to target offsets to mitigate these impacts. There was no consistency found in the methods for accounting for these impacts, or who bears the responsibility for offsets at the institutional or department level. The lack of any formal accounting for air travel at Duke is clearly an issue that needs to be addressed. As with the adage, "what gets measured, gets managed" -- without clear accountability of usage and impacts, efforts towards behavior modifications and/or meaningful offset programs are seriously hindered.

Alternative Transport Modes

In many institutional settings, there are more environmentally benign options to air travel for one-way trips in the 250 to 500 mile range – for example intercity rail and express bus services. Duke is more disadvantaged in this regard as evidenced by the alternative modes available to destinations like Washington DC or Atlanta, GA (see Exhibit 23).

Exhibit 23 Comparison of Travel Options for Two Regional Destinations: Washington DC and Atlanta GA

Origin-Destination	Air Options	Rail Options	Bus Options	Auto Options
Durham to Washington DC				
Connection	Direct Flights	80 Carolinian	Greyhound	Flexible
Departures/Travel Times	Various/3:00 hours (inclusive)	1 AM/6:45 hours	1 AM /8:50 hours 1 PM /12:45 hours	4:25 hours
eCO2 per one-way passenger trip	0.08 metric tons	0.06 metric tons	0.02 metric tons	0.09 metric tons(1) 0.05 metric tons (2)
Durham to Atlanta, GA				
Connection	Direct Flights	79 Carolinian/ 19 Crescent	Greyhound	Flexible
Departures/Travel Times	Various/4:00 hours (inclusive)	1 PM/8:54	2 AM/10:40 hrs 2 PM/10:40 hrs	6:10 hours
eCO2 per one-way passenger trip	0.20 metric tons	0.15 metric tons	0.05 metric tons	0.13 metric tons (1) 0.08 metric tons(2)

1 Assuming 25 miles per gallon vehicle with a single occupant
2 Assuming 40 miles per gallon vehicle with a single occupant

The quality of the existing connections would require significant incentives or cost benefits to encourage any significant shift from air travel to rail or bus use. This leaves the automobile as the primary alternative to short haul air travel. When comparing average emissions associated with travel to the Washington DC area with an average automobile trip (single occupant), the emissions are comparable; however, if the automobile trip is made by a "greener" vehicle, the impacts of travel by automobile could be 35 percent less than by airplane. Furthermore, if the automobile travel was shared by two individuals, the environmental impacts would be about half of the alternative trip by air travel. The effects of these shifts are even more dramatic for travel by air to Atlanta, which is further influenced by the negative effects of plane travel at higher altitudes. Campus travel decisions would be more consistent with the University's climate goals if education on alternative modes and their environmental effects is made available during travel planning to all Duke constituents. The dissemination of this information is made somewhat more difficult by the obsolescence of the traditional travel agent but might be accomplished by educational programs targeted at the department level.

Input from Duke Constituents

Input received from Duke constituents during a workshop held in December 2008, suggested that the most viable options for Duke University to manage air travel are within the family of policy and educational strategies. There was mixed feedback on whether adequate video-conference facilities exist on-campus, but general consensus on a lack of knowledge of facility availability, or scheduling protocol, and the need overall for technology training. There was general support from workshop attendees on the need to: hold departments accountable for air travel offsets; target mitigation strategies, to the extent practical, toward air travel demands; and work more proactively with the public sector (become advocates) on regional transportation alternatives (specifically emphasized was improved rail service).

Air Travel Actions

While not specifically quantifiable, the following actions are being put forward as the most promising strategies to help manage air travel emissions at Duke and/or mitigate their impacts:

- **Establish a Mechanism for Accounting for Air Travel Usage at the Department Level to Include Trip Itinerary and Purpose.**
  These data will enable additional management and educational strategies to be developed over time.
- **Establish More Environmentally Responsive Air Travel Policy**
  Strengthen Duke University's air travel policy to educate constituents on the environmental impacts of air travel, provide information on travel options for trips of less than 500 miles, discourage discretionary travel that could be substituted for video conferencing, restrict use of private aircraft, discourage business /first-class travel, encourage direct flights where practical, and require departments to account for air travel and be responsible for offsetting the associated impacts.
- **Provide Video Conferencing Resources**

Educate faculty, staff and students on available video conference facilities and establish protocols for scheduling facilities. This program should be accompanied by a technology training or support program to measurable increase the utilization of video conferencing.

- **Investigate On-line/Collaborative Ridesharing Partnerships**
  Consider the viability of on-line connections to facilitate ride sharing to training or conference events that attract a broader constituency from the Research Triangle Area.
- **Incentive/Promotion of Options**
  Provide and promote green cars (via Zip Car or through the Duke motor pool) for conference attendance or other Duke-related travel for traditional air travel trips; consider taxi vouchers to the train and bus stations; and consider gift certificates or other financial incentives to carpoolers to regional conference events or meetings.
- **Target Offsets Toward Student Air Travel or Similarly Predictable Trip Patterns**
  Investigate the feasibility of providing direct (express)bus services during peak travel periods to markets in the 200 to 400-mile range where a density of Duke students live.[24]

Analysis of Fleet Options

While fleet operations (both service vehicles and transit vehicle use) represent only 5 percent of the total Duke University emissions inventory, or about 1 percent of overall emissions, these vehicles represent the most visible statement of Duke's transportation sustainability intentions. The analysis of the potential GHG reductions associated with Duke's fleet was focused in three areas: greening the existing service and administrative fleet; replacing the transit fleet over time with more environmentally friendly vehicles; and, eliminating inefficient transit routes, if possible.

Greening the Existing Fleet

As Duke replaces the fleet that is currently used by campus facilities and departments, it can make measurable change in the environmental impacts of these vehicles by appropriately tailoring the vehicles to their intended use and optimizing their fuel efficiency. This means setting policy to exceed national Corporate Average Fuel Economy (CAFE) standards and establishing a plan of action to procure more fuel efficient vehicles, target a portion of the fleet to be switched out for electric vehicles or bicycles[25], and right-sizing the entire fleet.

There are currently 582 cars, small trucks, trucks, and vans in the Duke fleet, of which approximately 74 percent are vans and trucks. These vehicles are replaced at an average annual rate of about 30 vehicles per year. The analysis of the effects of greening this fleet assumes the current rate of replacement and that the fuel efficiency of the fleet tracks with national policy to improve CAFE standards by 40% by 2020 (to 35 miles per gallon). The effects of fleet renewal, in terms of efficiency gains and GHG percent reductions, are summarized in Exhibit 24.

[24] A similar for-profit service provided at Boston College to New Jersey, Long Island, and Westchester County, NY and captures as much as 20 percent of the student market during peak travel periods, such as Thanksgiving break.

[25] Harvard University has a fleet of bicycles that are used for a variety of service and administrative trips around and between campuses.

Exhibit 24 Estimated Fuel Efficiency Increases and GHG Reductions Due to Fleet Replacement (Exclusive of Transit Fleet)

Year	Average Age t of Fleet	Est. Average Efficiency	GHG Reduction from Base
2008	1998	18.5 mpg	--
2010	2000	18.5 mpg	0%
2015	2005	19.8 mpg	6%
2020	2010	23.8 mpg	21%
2030	2020	33.8 mpg	45%
2040	2030	43.8 mpg	58 %
2050	2040	50 mpg	63%

As noted by the exhibit, GHG emissions from Duke's fleet are estimated to decrease by 21 percent by 2020 and 63 percent by 2050. These reductions, in the near-term, have been conservatively estimated to principally take advantage of expected improvements in the CAFE standards; however, Duke can make a commitment to exceed these targets through strategic deployment of electric vehicles and bicycles.

Transit Fleet Replacement

Duke's Transportation and Parking Services provides extensive transit services for its constituents with a fleet of 39 buses. Buses in this fleet range in age from 1992 to 2008, but more than a third of the fleet (14 buses) are in fair to poor condition. As this fleet is replaced, an emphasis should be placed on purchasing vehicles that make a statement about Duke's commitment to quality transit services and sustainability. Current thinking is to target the main East-West C-1 route (and possible the C-2) with hybrid electric diesel bus rapid transit (BRT) type vehicles. This would achieve three desirable outcomes: provide a high visibility, state-of-the-art transit connector, improve the efficiency of the operation during peak periods by increasing the passenger load per vehicle, and capitalize of the fuel efficiency and cleaner emissions inherent in vehicles being brought to market today.

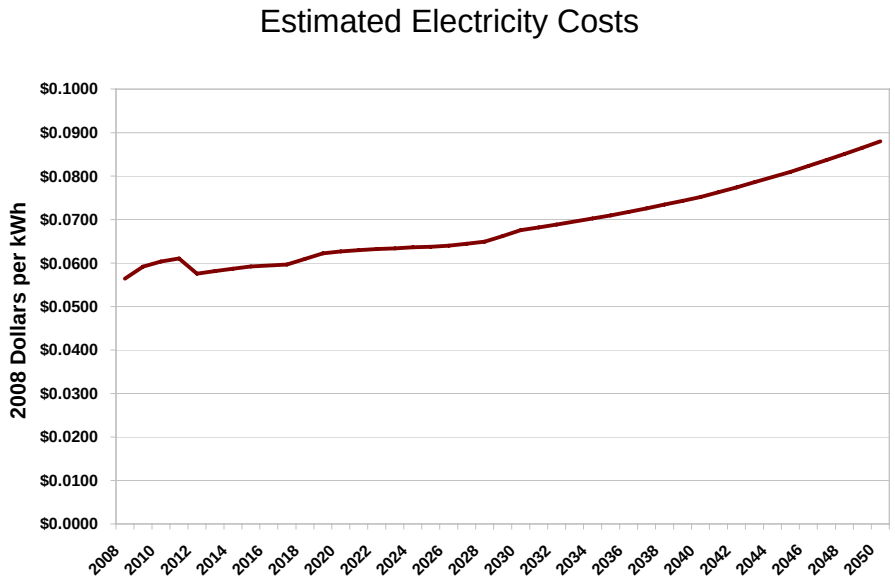
For this analysis, it was assumed that Duke would replace 10 buses within the next two years, followed by 10 new buses by 2013, 10 new buses in 2018 and replacing 10 buses every five years thereafter through 2050. Fuel efficiency and emissions data on transit fleet operations vary significant by service setting, usage, and source. Based on manufacturer information and a recent study commissioned by the Federal Transit Administration (FTA), fuel efficiency gains (hybrid over diesel) could range from 20 to 40 percent and GHG tailpipe emission reductions of 15 to 26 percent. In addition, using a BRT fleet on the C-1 could reduce overall vehicle miles traveled by up to 30 percent during peak periods by servicing the same demand with fewer, larger capacity buses. Taking all of these factors into account, the analysis of emissions reductions related to transit fleet replacement assumes a 50 percent reduction in emissions for replacement vehicles. These efficiency gains are cycled into the system as investments in new equipment.

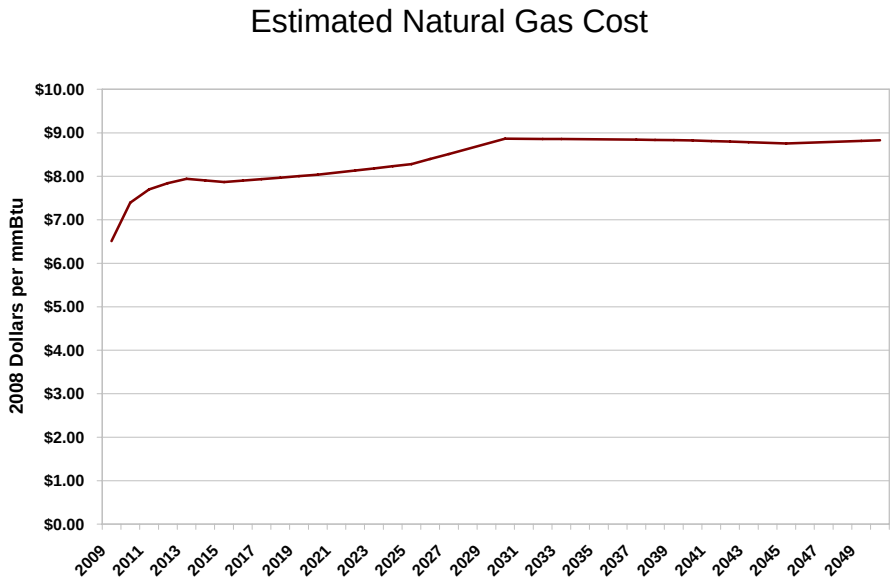
Elimination of Inefficient Transit Routes

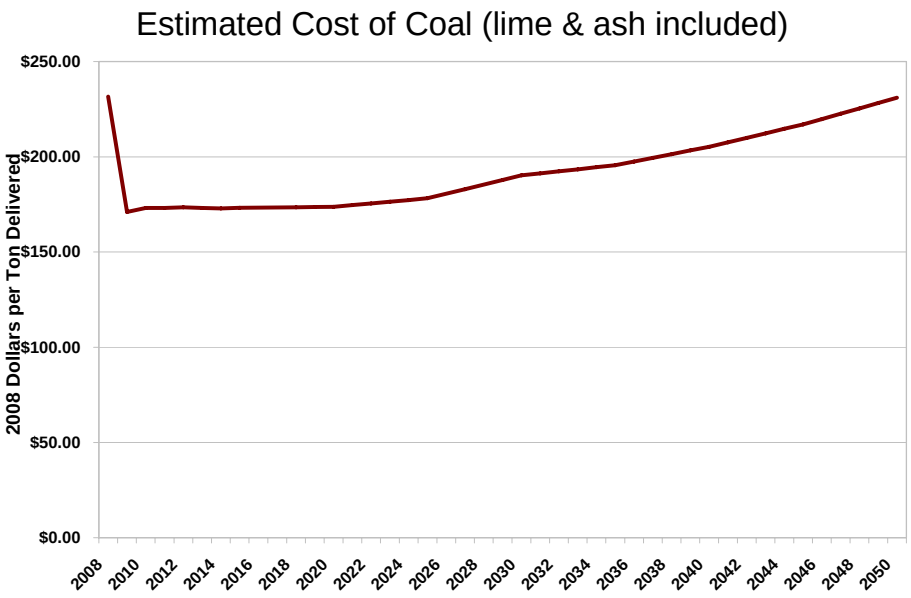
In conjunction with the overall transportation system improvements, including the expanded use of park and ride facilities and furthering the university's partnership with DATA and TTA, there is potential to decommission several existing Duke operated transit routes. Specifically, eliminating the H5 and H6 routes will result in both cost savings and GHG reductions. Based on 2007 shuttle statistics, these routes accounted for approximately 215,000 vehicle miles traveled annually, or about 28 percent of Duke's transit service mileage. Adjusting for the fact that these routes are covered by both vans and buses, it is estimated that the elimination of these routes will result in a reduction in transit-related fleet emissions of about 15 percent.

Appendix C – Energy

Energy savings and costs were based on the projections of future energy costs provided by Duke's Nicholas Institute for Environmental Policy Solutions and the Climate Change Policy Partnership (CCPP). The projections are based on output from the Adage model assuming Federal carbon legislation is in place in 2012. Since the model outputs are a broad estimate of energy prices across the country, the annual changes shown by the model output were applied to the prices Duke currently pays for coal, natural gas, and electricity. This application provides a projection of future energy cost that is customized for Duke based on current energy costs






Estimated Cost of Coal (lime & ash included)
2008 Dollars per Ton Delivered
$250.00
$200.00
$150.00
$100.00
$50.00
$0.00
2008
2010
2012
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Appendix D - Education

	Sustainable Duke Office	Duke Recycles	Environmental Alliance (EA)	Professional Student Org's	CSC Communications Subcommittee
Competitions	working on Inter-collegiate competition	Recyclemania, Recycle for the Children	Eco-Olympics	Farmhand's Local Food Challenge, Net Impact's "Green Week"	
Pledges/ Challenges	Sustainable Duke Pledge			Farmhand's Local Food Challenge, Net Impact's "Green Week"	
Tabling at Campus Events	Earth Jam, New Student Orientation, Earth Month	New Student Orientation, Earth Month	Earth Jam, Earth Month	Earth Month tabling	
Presenting to Residence Halls or Student Org's	Focus, Crash Course, RA Training,	Presentations on Recycling			
Newsletters, Listservs, Bulletins	Sustain-e Newsletter (bi-monthly)	Facebook site	enviros list	greening list	
Web Sites w/ Sustainability Information	Sustainable Duke is a clearinghouse for all campus sustainability information	FMD sustainability page is not updated regularly	seasonally updated	Net Impact: page/list, DUGI: page/list, Farmhand: list	articles for Working@Duke, News & Communication stories, Duke OnCamera
Canvassing/Social Marketing	Students for Sustainable Living (SSL), Pledge Bag, Stickers, T-Shirts		Eco-Olympics, Light Bulb Giveaways		
Orientation	Sent information to include in orientation guide, (Zero-waste) Freshmen Picnic, Employment & Dept. Resource Fair	Employment & Dept Resource Fair, composting for zero-waste picnic			
Grants / Funding for Projects	Green Grant Fund	EMAC			
Earth Month (April) Activities	Co-coordinates: Earth Month Committee	Co-coordinates: Garbology Project	tabling, movies series	Speaker, tabling	
Community Garden	Students for Sustainable Living (SSL) involved in planning	Student Employees involved in planning		Farmhand Honey Patch Garden in Duke Gardens	

Sample of Sustainability Courses, 2008-2009 Academic Year

Courses

Duke's Sustainability Office compiles a list highlighting several of the sustainability courses in all colleges and departments each semester. Please email us to suggest additional courses for the current, or upcoming semester.

Spring 2009 Sustainability Courses

Course	*Title*	*Time*	*Instructor*
Bio 43.01	Ecology and Society	TTH 10:04-11:20	Reid
BIO 125	Biology and Conservation of Sea Turtles	TBA	Eckert
PolSci 152S.01	Environment in Conflict & Peace	MW 2:50-4:05	Weinthal
ENV/SOC 171	Food and Energy	MW 10:05-11:20	Clark
SOC 198	Environmental Justice	W 6:00-8:30	Kall
PubPol 187S	Marine Conservation Science	TTH 2:50-4:05	Sagarin
EOS 251S	Global Environmental Change	W 2:50-5:20	Baker
ENG 169AS	Frontier Ecologies	TTH 1:15-2:30	Eklund

Fall 2008 Sustainability Courses

Course	*Title*	*Time*	*Instructor*
PubPol 195S.10	Collective Action Development & Env.	W 1:30-4:00	Pfaff
Econ 272.01	Resource and Environmental Economics	TTH 10:05-11:20	Martin
PubPol 285.01	Land Use Principles and Policy	TTH 8:30-9:45	Salvesen

Appendix E - Communication

Strategies to Increase Awareness/Exposure for Duke's Sustainability Efforts
Drafted: January 2007
Updated: July 2008

Leadership
Since a sustainability coordinator was hired in 2004, Duke has done a much better job at identifying and promoting sustainability efforts. But the awareness and exposure of these efforts pales in comparison to the investments made and initiatives undertaken. Still, a coordinator alone cannot provide the administrative gravitas or academic credibility to generate more visibility and action on this front.

A steering committee made up of key administrators, faculty members and students would help harness Duke's intellectual, creative and administrative horsepower to focus its collective sustainability efforts in ways that provide greater opportunities for internal and external exposure.

The committee should contribute to and endorse the annual and long-term plans for sustainability at Duke that are developed by the coordinator. The committee should be co-chaired by a senior administrator to serve as the great enabler for change on campus and a distinguished environmental faculty member to be the academic/research champion on sustainability issues. Representatives from other key areas such as Facilities Management, Procurement, the Nicholas School, Transportation, Community Relations, News & Communications, etc. should also be considered.

> **2008 Update:** The Campus Sustainability Committee was established in 2007 to create institutional structures to guide the development and implementation of a plan to become climate neutral at Duke. The committee is chaired by EVP Tallman Trask and William Chameides, dean for the Nicholas School of the Environment, includes subcommittees on Energy, Transportation, Offsets, Education, and Communication.
>
> In April 2008, Trask and Chameides hosted a Primetime employee forum, which drew about 300 individuals, many for the first time. The articles and video about the event posted on Duke Today drew another 400+ visitors. More than 90 percent of those surveyed at the event valued the opportunity to hear from Duke administrators and 75 percent left with a better understanding of sustainability.

Identity
Awareness of sustainability efforts at Duke suffer from a lack of common identity. Many identities have cropped up during the last few years. While well intentioned, the multiple efforts and visual identities (Sustainability@Duke, the Duke Greening Initiative, Duke Green Power, Green Grant Fund) fragment the understanding and awareness of Duke's overall sustainability mission and core messages.

A single visual identity could help unify multiple efforts, including many ad hoc projects or independent activities, under a larger umbrella that could begin to represent sustainability across Duke, much the same way the Hurricane Katrina Relief image propagated across Duke web sites to represent different support efforts.

> **2008 Update:** The Green Devil was developed as a central image to represent sustainability efforts in late 2007. It has since become the common identifier for multiple efforts among students, faculty and staff across Duke. The tagline "Bleed Blue. Live Green." similarly has become a central theme used by various sustainability groups and efforts.

Create Buzz

In order to attract media attention, especially national outlets, there needs to be a bigger event or issue to garner interest. Such coverage typically includes information about other sustainability efforts as context and background. Duke should leverage its resources and academic mission to consider a few marquee events that would attract broad attention on sustainability issues to shine the light on the many other efforts on campus.

For instance, hosting national figures such as Al Gore with a special showing of his documentary "An Inconvenient Truth" could attract broad media coverage, which would help put Duke's name prominently on the map of the sustainability issue. Other public figures such as Ralph Nader and business leaders from companies such as Burt's Bees, Siemens, Toyota or could also be invited as part of a special lecture series on sustainability. The development and habitation of the Smart House also hold significant marquee appeal, especially if used in conjunction with social media such as blogs, podcasts or streaming video to chronicle student experience of residential living in this unique dorm.

> **2008 Update:** On Jan. 31, 2008, Duke took advantage of two events that coincided to showcase its leadership role in sustainability and raise its green profile nationally. On Jan. 31, the Duke men's basketball team played N.C. State University in a nationally televised game on ESPN2; the same day Duke and thousands of schools across the country participated in Focus the Nation. Nearly 1,500 members of the Duke community signed the Sustainable Duke Pledge at events throughout the day, and 1.46 million viewed the "Green Game" on TV. The game resulted in significant media coverage afterward, including USA Today, the Weather Channel and The Chronicle of Higher Education.

Coordinate Communications

A communications committee should be convened by the Office of News & Communications to bring together communication professionals from the many departments and schools that have a hand in sustainability efforts to coordinate internal and external efforts. The group would be charged with devising and implementing effective strategies to garner greater media attention and community recognition for Duke's sustainability work.

The committee should leverage resources among members to create an expert list for media, take advantage of existing relationships with media and trade publication contacts, and coordinate public relations efforts. The tactics should cover the full range of internal media such as Duke Today, Working@Duke, Primetime, etc. to build awareness within Duke's internal community. Other tactics should be explored as well, including student projects through Documentary Studies that may help chronicle the issue and Duke's efforts using alternative or social media.

This committee should have at least one representative on the larger steering committee to ensure communication is considered in larger planning efforts and to provide feedback to the communications group regarding priorities, current projects and future plans.

> **2008 Update:** A subcommittee from the Campus Sustainability Committee has established in 2007 to coordinate communications based on the priorities and goals developed by the larger committee. The committee includes representatives from the Sustainability Office, the Office of Communication Services, the Office of News and Communications, Student Affairs and graduate and undergraduate students.
>
> These efforts led to a consistent and multidimensional communication approach that included a regular feature called "Sustainable Duke" in Working@Duke, videos and articles on Duke Today, increased media exposure, a well attended employee forum and consistent rankings as a top university for sustainability.

Think Bumper Stickers

Bumper stickers such as "Think Globally, Act Locally" capture the essence of moving sustainability out of the board room or architect's office and into the everyday lives of those who work and study at Duke. Sustainability must be seen as a shared responsibility, and strategies should be developed to engage people, which will also help tell the story and create ambassadors for sustainability. For example, a volunteer event to collect and sort recyclable materials after a football game could create a media opportunity and help others feel engaged in the larger effort of sustainability. People should be encouraged to participate in and celebrated for activities that support sustainability, whether volunteering in Durham, tutoring employees, purchasing recycled paper or conserving energy.

> **2008 Update:** In 2008, the Sustainable Duke Pledge was introduced to encourage individuals to take actions that can help create a more sustainable environment on campus. The pledge and the Green Game also introduced the tagline: "Bleed Blue. Live Green." The tagline is now frequently used in many areas to identify and promote sustainability efforts. As of July 2008, more than 1,660 individuals had taken the pledge, and more than 800 people had purchased the "Bleed Blue. Live Green." shirts from Duke Stores.