NC STATE UNIVERSITY

NORTH CAROLINA STATE UNIVERSITY

CLIMATE ACTION PLAN

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EXECUTIVE SUMMARY

The first Climate Action Plan (CAP) for North Carolina State University (NC State) is one way to infuse sustainability into the essence of the institution. In 2008, NC State became a signatory of the American College and University Presidents Climate Commitment (ACUPCC), a national pledge of those at colleges and universities to both recognize the climate impact of their campuses and work to reduce their greenhouse gas (GHG) emissions. The CAP is the result of collaborative efforts among staff members, faculty members, students, and third-party engineering and economic experts. The purpose is to create goals and strategies that will help NC State reduce GHG emissions and ultimately the potential impact on the environment.

The overall goal regarding potential climate impact at NC State is to achieve climate neutrality by 2050. The first step to achieving neutrality is understanding the potential impact that current and future GHG emissions have. The next step is to lay the groundwork for change by exploring available opportunities. Lastly, is to implement strategies and monitor and measure progress. The purpose of the CAP is to create a framework and provide supporting information to assist in decision-making.

NC State's portfolio contains a variety of strategies, that if implemented would help lead NC State towards climate neutrality. The first iteration of the plan focuses on strategies developed for implementation in the near-term, or within the next five years. The five year strategies in the CAP could result in approximately a 20% GHG reduction from 2008 levels by 2015. Similar strategies are grouped into categories, referred to as wedges. The wedges chosen for the CAP are: green development, energy conservation, fuel mix and renewables, transportation, and waste management. The plan also examines how some of the larger, long-term changes to existing infrastructure might impact the University's GHG emissions.

Sustainability, climate impact, and energy are themes for creating synergy in planning efforts. The process utilized the Campus Environmental Sustainability Team (CEST) and associated working groups to provide ideas, feedback, and insight. The CAP, along with the Strategic Energy Management Plan, are supporting documents for the Sustainability Strategic Plan. All three plans compliment each other and a streamlined tracking of progress moving forward ensures goals are met on a broad sustainability scale. Implementation measures will include establishing specific tactical steps, responsible parties, and performance metrics.

Though many of the strategies proposed to mitigate carbon emissions on campus require physical modifications to buildings and infrastructure, an equally important goal is the need for a culture change related to how the campus community views natural resources. Including sustainability at the core of the University's identity will require creating a new culture of sustainability. This culture is guided by principles that place sustainability as a priority at NC State. In turn, creating the new culture of sustainability requires recognition of a new community at the University. This community will operate with students, faculty and staff as largely independent groups as a collaborative community who plans for the sustainable future of NC State.

The creation of the CAP is one of the first steps on the journey towards climate neutrality. The University now has a road map for which to help guide decision-making and planning into the future. NC State is already making significant headway in many of the identified strategies. Each of these efforts is moving NC State closer to climate neutrality. Climate neutrality by 2050 is possible through maintaining momentum and realizing reductions today while continuing to plan for the future.

1. A CLIMATE FOR CHANGE

There are many important reasons for creating a Climate Action Plan (CAP). In 2008, NC State University became a signatory of the American College and University Presidents' Climate Commitment (ACUPCC), a national pledge of those at colleges and universities to both recognize the climate impact of their campuses and work to reduce their greenhouse gas (GHG) emissions. The commitment includes creation of a comprehensive plan to achieve climate neutrality, tangible actions to complete while the plan is being developed and to make the inventories, plan and progress reports publicly available. More specifically, the commitment asks that campuses work to achieve climate neutrality as soon as possible.

The overall goal regarding potential climate impact at NC State is to achieve neutrality by 2050. "For purposes of the ACUPCC, climate neutrality is defined as having no net greenhouse gas emissions, to be achieved by eliminating net GHG emissions, or by minimizing GHG emissions as much as possible, and using carbon offsets or other measures to mitigate the remaining emissions."[1] In the most simple approach, reducing GHG emissions to zero would allow the University to attain climate neutrality. GHG emissions are directly tied to fossil fuel combustion needed to provide electricity, heating, cooling, transportation, and other services.

The first step to achieving climate neutrality is understanding the impact that current and potential future GHG emissions have. The next step is to lay the groundwork for change by exploring available opportunities. Lastly, is to implement strategies and monitor and measure progress. The purpose of the CAP is to create a framework and provide supporting information to assist in decision making.

[1] *ACUPCC website - http://www.presidentsclimatecommitment.org/about/faqs#10*

2. PLANNING FOR THE FUTURE

Sustainability, climate impact, and energy are themes for creating synergy in planning efforts. The CAP serves as a supporting document to the Sustainability Strategic Plan[2]. Additionally, the Strategic Energy Management Plan[3] offers specific information in focus areas that directly relate to the CAP. Ultimately, the goal is to strengthen the development of each plan through collaboration.

An essential component to the success of any large University planning effort is to garner the support and involvement of the campus community. The CAP sought to incorporate the valuable input and expertise the campus has to offer. The plan utilized the expertise and participation of a diverse group of students, staff members, faculty members, subject matter experts, consultants, and interested parties (**Appendix A**). More specifically, the process involved the Campus Environmental Sustainability Team (CEST) and associated working groups to provide ideas, feedback, and insight. Working group participation is open to anyone and thus input was gained from students, staff members, faculty members, and community members.

The following are the CEST working groups:

- Academics and Research
- Buildings
- Communications
- Energy and Water
- Land Use
- Materials Management and Purchasing
- Transportation
- Waste Reduction and Recycling

A group of consultants facilitated the CAP development process. The lead firm Affiliated Engineers, Inc., along with subconsultants Energy Strategies and Martin/Alexiou/Bryson created a team of subject matter experts to perform the information collection and analysis. The experience of the consultant team in creating climate action plans for other universities assisted in the development of a comprehensive and usable end product.

The plan development process began with engaging each of the working groups to generate ideas for ways that NC State could mitigate GHG emissions. The working groups used five-year sustainability strategies developed for the Sustainability Strategic Plan as a starting point.Each group thought about their area of focus from a carbon management lens and looked forward to the 2050 time frame. The consultants grouped a list of more than 200 ideas into themes to create the strategies to consider for the CAP. The consultants also gave suggestions of strategies that would have a positive effect on GHG emissions.

The list of ideas for reducing GHG emissions was qualitatively evaluated by the working groups based on potential GHG impact as well as assessed based upon broader sustainability considerations. The evaluation results helped to condense the remaining ideas and categorize by theme. The result of this evaluation was a shorter list of items that was given a more quantitative evaluation for inclusion in the final GHG reduction portfolio, or compilation of strategies that can be utilized in the future.

In total, 30 strategies were analyzed and considered for the University's GHG reduction portfolio. The next step was a detailed financial and GHG analysis of each of the 30 ideas using technical GHG and financial metrics. The modeling took into account the start up and operational costs, the impact of climate related legislation and the overall impact on GHG emissions of each individual strategy. After the assumptions for each strategy were verified, the model provided detailed information that was used to help select the strategies for the GHG reduction portfolio. The information was organized into a graph called an abatement curve that shows both the cost and GHG reduction of each of the 30 strategies (**Appendix D**). From this information, 17 strategies were selected and endorsed by CEST to create the GHG reduction portfolio. The final step was the creation of the CAP document to help give an overview of the opportunity NC State has to reduce potential climate impact.

[2]Sustainability Strategic Plan - http://sustainability.ncsu.edu
[3]Strategic Energy Management Plan - http://sustainability.ncsu.edu

3. UNDERSTANDING ABATEMENT

In order to have a frame of reference for carbon abatement, It is necessary to understand a variety of terms, acronyms and concepts (**Appendix B**). GHG emissions are measured in terms of metric tons of carbon dioxide equivalent, or MTCDE. The convention is to use the equivalent of a metric ton of carbon dioxide for equating the environmental impacts of other greenhouse gases. Due to this metric, oftentimes the word carbon is used interchangeably with the term GHG. One metric, MTCDE, measures six greenhouse gases including carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, hydro-fluorocarbons and per-fluorocarbons based on their relative global warming potential. GHG emissions are categorized into scopes. Scope 1 emissions are direct emissions from the University and include items such as fuels and refrigerants. Scope 2 emissions are indirect emissions from purchased electricity, which in NC State's case is from Progress Energy Carolina, Inc. Scope 3 emissions are also indirect emissions from activities such as commuting, air travel, and waste disposal.

The hierarchy of carbon management is important to understand (**Figure 1**). The first priority is to avoid carbon intensive activities where possible, such as walking as opposed to driving. Next is to reduce carbon emissions by being more energy efficient. The third priority is to replace high-carbon energy sources with low-carbon sources, such as the use of natural gas instead of petroleum. Lastly, is to offset any emissions that were not eliminated by one of the previously mentioned techniques.

Another important consideration is that future legislation on the federal or state level could regulate GHG emissions. Any carbon related legislation would apply a price to carbon. If so, the costs and benefits of GHG abatement shift.

The boundaries of both the GHG inventory and the CAP are also important to understand when considering the opportunities for reducing climate impact. The CAP deals specifically with the emissions and boundaries calculated in the 2008 GHG inventory as a baseline. For the first iteration of the plan, embodied energy is not addressed but rather the focus is on the items identified in the GHG inventory. Embodied energy accounts for the energy used in the full lifecycle of an item, from production to transportation to disposal.

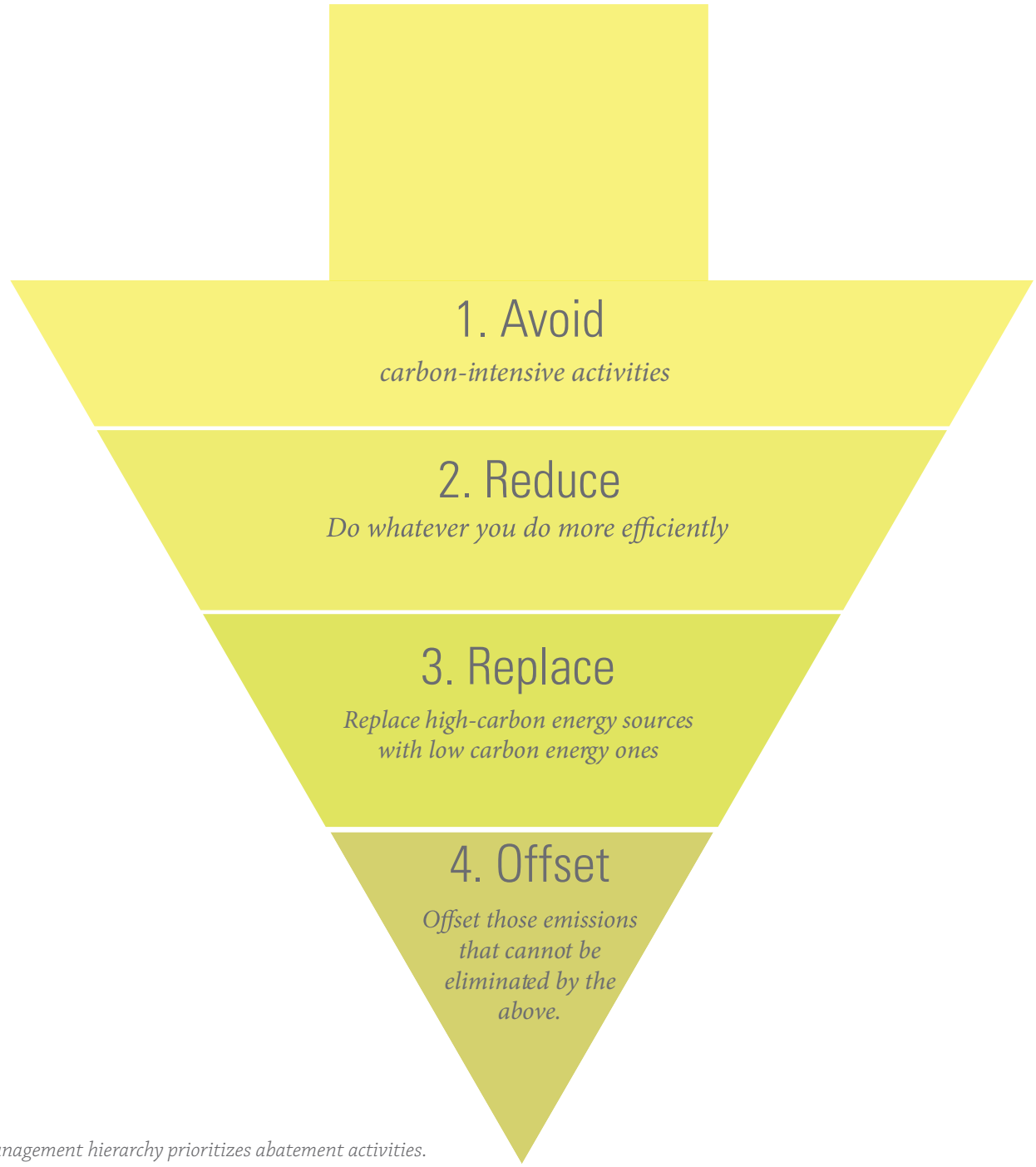

Figure 1.
A carbon management hierarchy prioritizes abatement activities.

4. GHG EMISSIONS TODAY & TOMORROW

Three campuses and over 100 satellite offices comprise NC State which amounts to over 15 million square feet with a population of over 39,900. The inaugural 2008 GHG Inventory[4] included the three campuses (Main, Centennial, and Centennial Biomedical) as well as satellite offices for which NC State manages the utility accounts. The other satellite offices not included have their utility accounts managed by another unit and are a joint endeavor between NC State and North Carolina Agricultural and Technical State University.

The time frame and methodology for the GHG inventory varied slightly depending on the type of information collected. Scopes 1 and 2 emissions are based on the calendar year 2008 for the possible implementation of federal or state requirements. Scope 3 emissions are based on fiscal year 2007 – 2008, since most University departments track their records on the fiscal calendar. The calculations for Scopes 1 and 2 are based on The Climate Registry and Scope 3 utilized Clean Air Cool Planet's Campus Carbon Calculator version 6 and Atmosfair's website for air travel.

The GHG Inventory created the baseline of emissions, at 270,069 MTCDE (**Table 1**). The 2008 inventory shows the majority of GHG emissions from the University are direct emissions from natural gas combustion and indirect emissions from electricity consumption and commuting (**Figure 2**). Scope 1 emissions account for 32% of the total and Scope 2 comprise 53% of the total emissions.The inventory did reveal one carbon offset attributable to composting of yard waste.

[4] *2008 NC State GHG Inventory - sustainability.ncsu.edu*

Table 1

Emissions totals from the 2008 GHG inventory displayed by scope and source.

2008 GHG Inventory Summary

Scope	Source	Emissions (MTCDE)	Emissions (%)
Scope 1	Natural Gas	60,956	22.57%
	Refrigerants	15,500	5.74%
	Emergency Generators	3,631	1.34%
	Fuel Oil	3,533	1.31%
	Vehicle (Gas)	2,249	0.83%
	Vehicle (Biodiesel)	580	0.21%
	Fertilizers	11	0.00%
Scope 2	Electricity	143,494	53.13%
Scope 3	Commuting	32,060	11.87%
	Air Travel	7,330	2.71%
	Solid Waste	1,194	0.44%
	Wastewater	95.3	0.04%
	Paper Purchasing	1	0.001%
Offsets	Composting	(568)	-0.21%
Total		270,069	100.00%

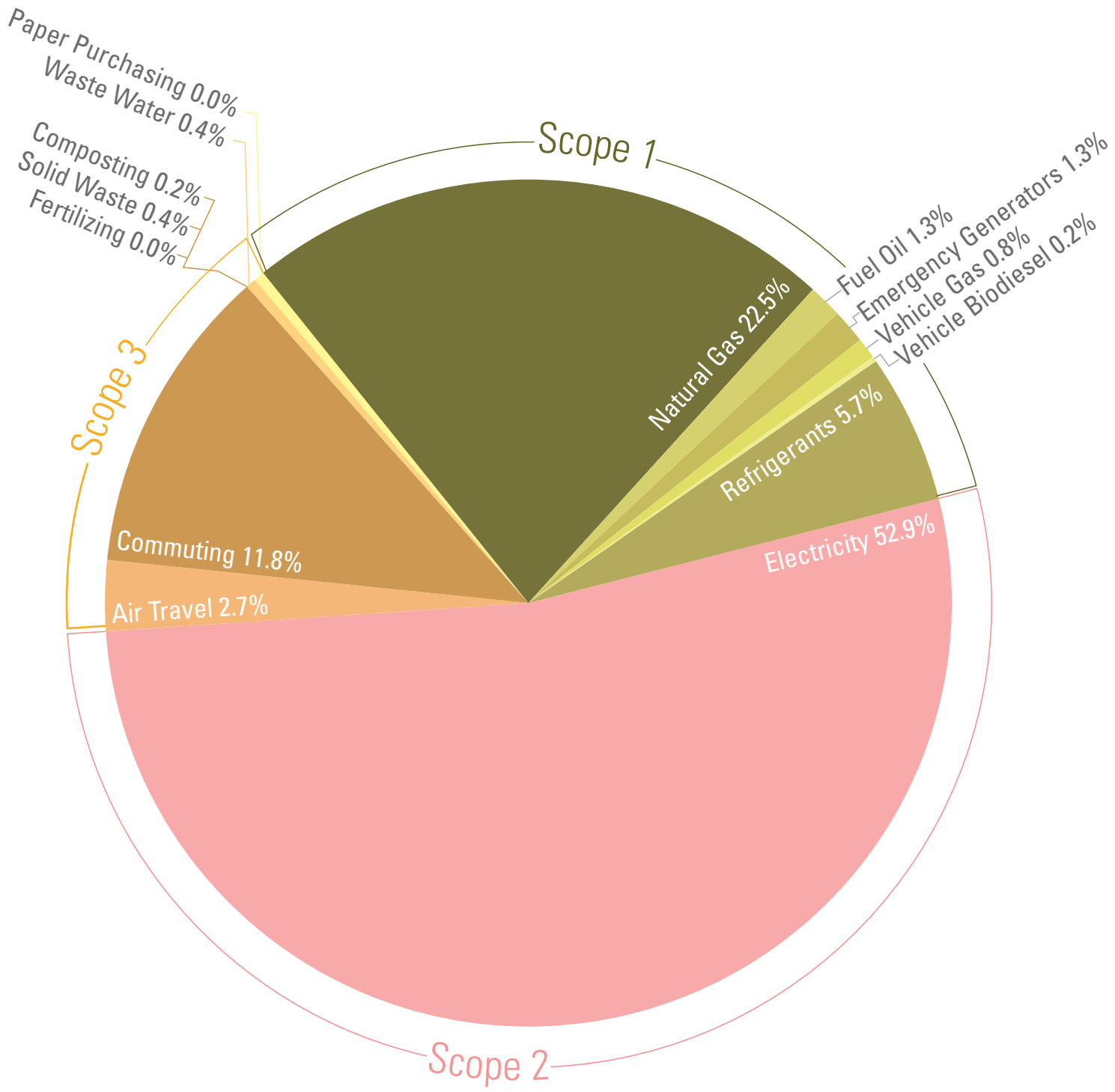

Figure 2

Percentage contribution of 2008 NC State GHG emissions by scope and source.

In order to begin planning towards climate neutrality, it is essential to understand what the University's emissions will be if no measures are taken to mitigate them. The next step in the process is to project the expected GHG emissions over time in a Business As Usual (BAU), or 'do-nothing', scenario. Essentially, this means estimating future emissions if the University were to continue operating with today's business practices. Available data were collected for growth in the campus population (**Appendix C, Figure 6**). The population of the campus drove the projected growth of the campus area (**Appendix C, Figure 7**). Reasonable assumptions were made to take the projected growth and apply the associated energy usage (**Appendix C, Figure 8**). The end result is the projected GHG emissions for the University through 2050 (**Figure 3**). Over the next 40 years, if NC State were to continue in a business as usual scenario, the campus's GHG emissions could rise to almost 400,000 MTCDE. As with NC State's current GHG emissions, the primary sources would be natural gas, purchased electricity and commuting in a BAU scenario. These projections were based on assumptions derived from available data and require revisions over time to create an accurate look at future emissions.

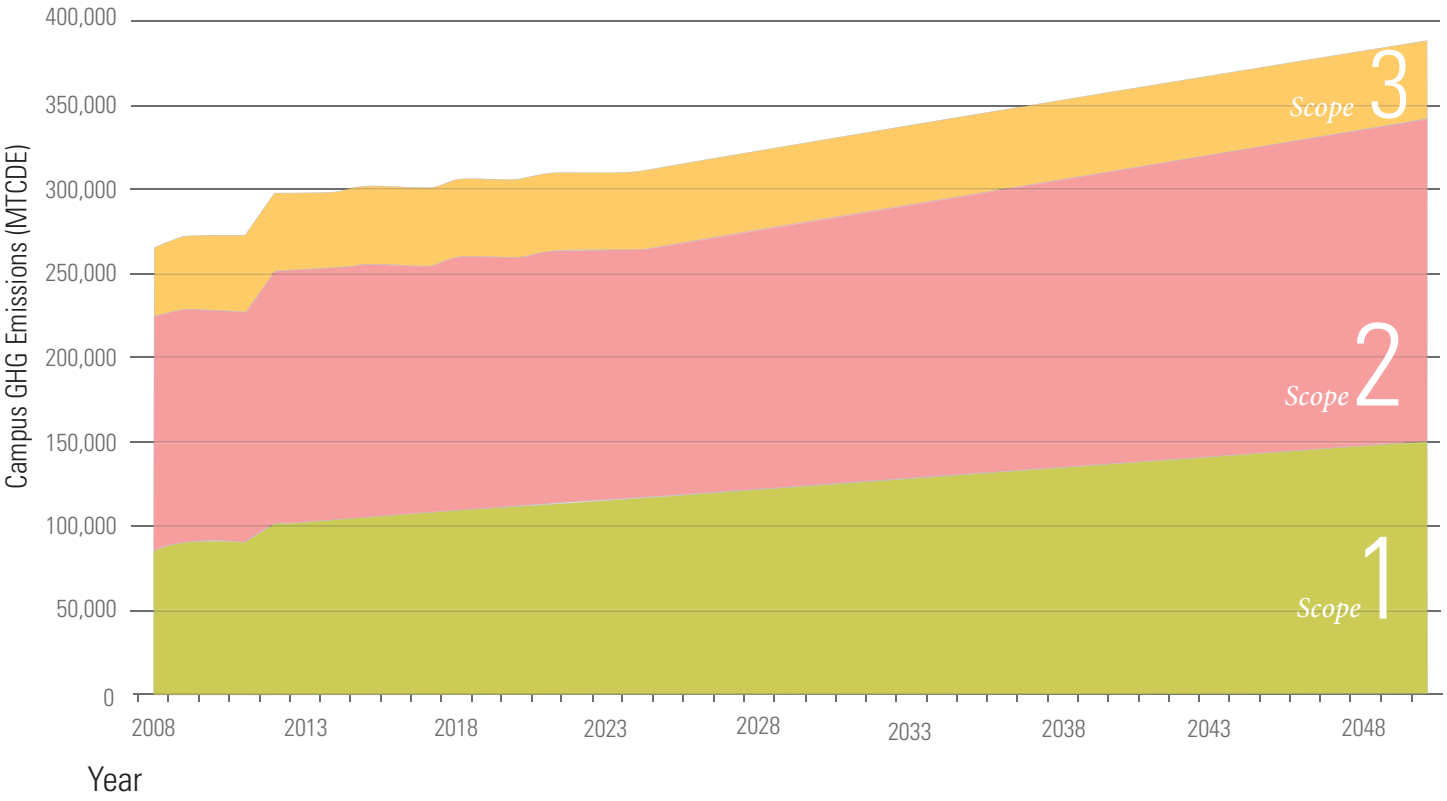

Figure 3

GHG emissions by scope in a "Business As Usual" scenario through the year 2050.

5. CREATING A PATH TOWARDS NEUTRALITY

The development of NC State's GHG reduction portfolio is one of the primary drivers for the creation of a CAP. The portfolio incorporates various criteria such as GHG impact, cost, and feasibility, then displays the collective potential impact of selected strategies over time. NC State's GHG reduction portfolio contains a variety of strategies that, if implemented, would help lead NC State towards climate neutrality.

5.1 *Near-Term Portfolio*

The CAP is based on a long-term goal of reaching climate neutrality by 2050. For the first iteration of the plan, the focus is on strategies that can begin implementation in the near term, or within the next five years. The near-term portfolio in the CAP could result in approximately a 20% GHG emissions reduction from 2008 levels by 2015.

The collective impact of near-term strategies on the GHG emissions of NC State through the year 2050 is illustrated in **Figure 4**. The red line at the top represents the projected GHG emissions in a BAU scenario and the blue line at the bottom represents the University's emissions after abatement. The wedges correspond with those in **Table 2** and capture the GHG reduction potential over the next 40 years. Though all of the wedges are equally important, it is apparent that the near-term strategies within the 'Energy Conservation' wedge offer the largest opportunity for GHG reduction. In addition, the 'Grid Footprint Change' wedge represents the benefit the University would receive from Progress Energy as they lessen GHG emissions within their energy supply. The dark grey section, Future Technologies, represents the remaining GHG emissions NC State might have to abate in order to reach neutrality by 2050. The

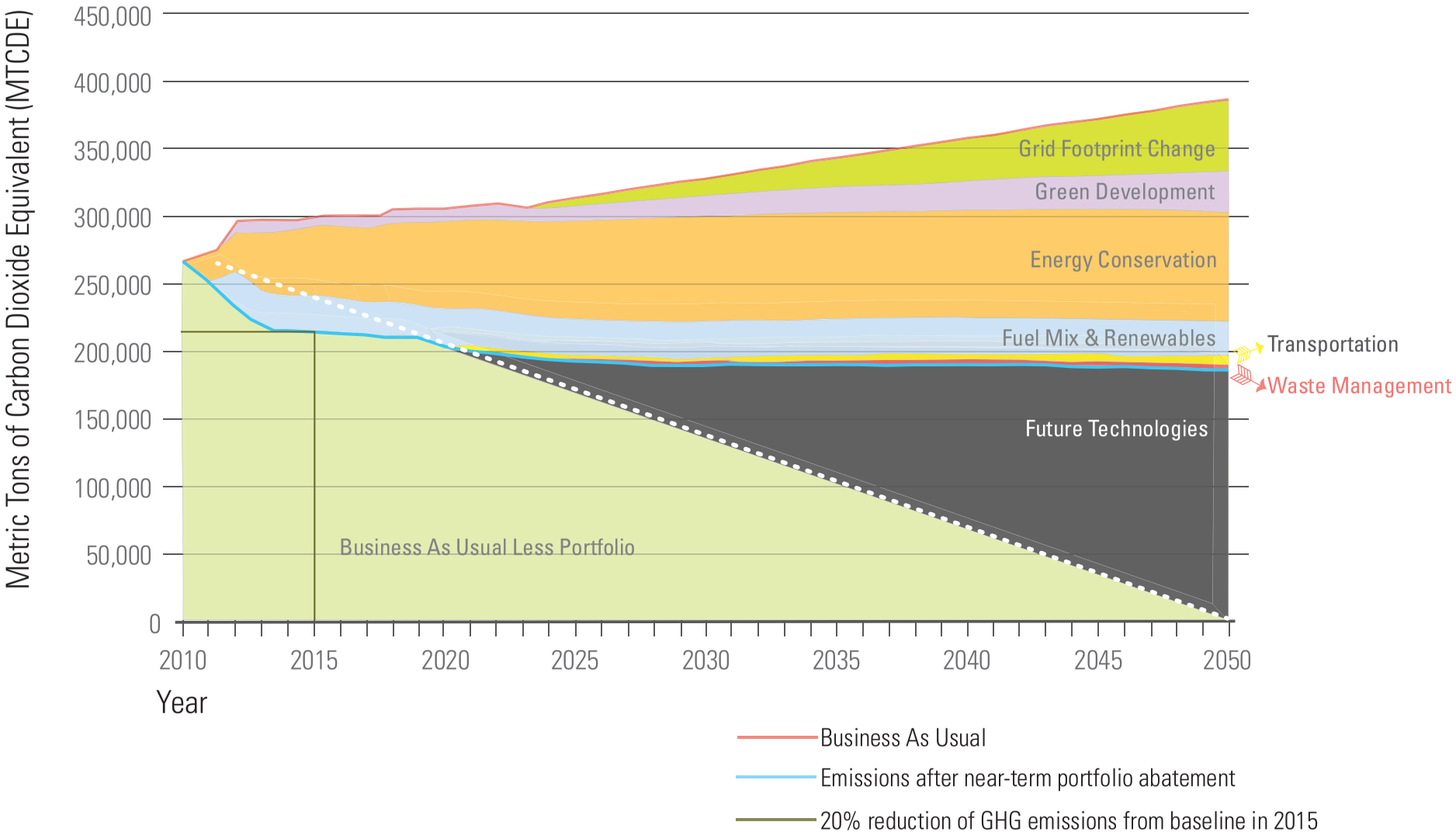

Figure 4

The carbon reduction of the near-term portfolio by wedge through 2050 shows the impact of five-year strategies over the next 40 years. A full description of the near-term portfolio wedges and corresponding strategies can be found in Table 2. Future technologies are fully discussed in section 5.2 and in Appendix E.

Table 2.
The near-term portfolio wedge table provides descriptions of wedges and corresponding strategies.

Wedges	Strategies
GREEN DEVELOPMENT Carbon reduction opportunities in space utilization, both inside and out, how buildings are constructed, and how land is managed	**Green Building** *Gains from compliance with the US Green Building Council's Leadership in Energy and Environmental Design Silver standard as well as NC Session Law 2007-546 on new campus buildings* **Space Planning and Management** *Opportunities for efficiencies in space allocation and use on campus* **Grounds Management** *The use of sustainable materials, equipment, and practices when maintaining the campus landscape*
ENERGY CONSERVATION Opportunities for reducing energy usage on campus	**Conservation Outreach/Behavior Change** *Opportunities available from changing energy use habits by the campus community* **Energy Conservation Measures (ECMs)** *21 different measures for reducing energy use in existing buildings* **Green Information Technology (IT)** *Conservation efforts that are possible within the IT infrastructure and management on campus*
FUEL MIX & RENEWABLES Opportunities for reducing GHG emissions in the University's energy supply	**Combined Heat and Power Plant at Cates** *More efficient source of energy for central campus* **New Boilers at Yarbrough Plant** *Efficiencies in the production of steam* **New Electric Chiller at Cates Plant** *Efficiencies in the production of chilled water* **Solar Photovoltaics – Buildings** *Utilize the sun's energy and convert it to electricity for buildings* **Solar Hot Water** *Uses the suns energy to heat the water needed for a building* **Geoexchange** *Use of the earth's constant temperature to reduce the energy use intensity on a building level*
TRANSPORTATION Opportunities for reducing GHG emissions related to how people get to, from and around campus	**Campus Fleet** *Conversion of vehicle types and fuel types as well as reduced usage of fuels needed for on campus travel* **Improved Commuting** *Options to reduce GHG emissions from employee and student commuting to and from campus and includes increased reliance on carpooling, transit, walking, biking, and telecommuting*
WASTE MANAGEMENT Opportunities to reduce the amount of solid waste the University sends to the landfill	**Waste Source Reduction** *Reducing the amount of materials used on campus thereby reducing the amount of waste produced* **Waste Diversion** *Diverting waste through an increase in recycling and re-use efforts* ***Composting** *Diversion and re-use of organic materials on campus* *(*Offers the opportunity for a carbon offset.)*

near-term strategies could lower GHG emissions to approximately half of what they may be 40 years from now in the BAU scenario. An important reminder is that the near-term portfolio represents the opportunities for GHG reduction in the future using the information and technology that are available today.

In order to best communicate the specific types of GHG reduction the University is considering, like strategies were grouped into categories, referred to as wedges. The wedges chosen for the CAP are: green development, energy conservation, fuel mix and renewables, transportation and waste management. Each wedge is comprised of strategies that were chosen because they are cost-effective methods for reducing GHG emissions. Additionally, many of the strategies within each wedge are simply general themes to help describe various projects and programs. **Table 2** details the wedges and 17 strategies that together comprise the near-term portfolio for the CAP. NC State will work to advance the strategies in the portfolio at every opportunity as they offer the best current solutions to creating a real reduction in climate impact.

5.2 Long-Term Portfolio

Given that the CAP covers a 40 year time line, the certainty of the University's actions, and the impact of those actions, on GHG levels become less accurate the farther out the projection. Updates to future emissions, actual and projected, as well as the availability, viability, cost and potential impact of future technologies are necessary to effectively manage the University's impact moving forward.

As shown in **Figure 4**, the dark grey section entitled 'Future Technologies' represents the remaining emissions NC State will have to abate in order to reach neutrality by 2050. However, it is possible to broadly look at how some of the potential larger, long-term changes to existing infrastructure might impact GHG emissions. The CAP developed long-term portfolio paths that are not deemed feasible in the near term, but are considerations for the future. Generally these strategies are some of the less proven and future technologies which, at this time, would require significantly more capital.

The long-term portfolio paths developed for the CAP primarily involve the use of alternative sources of energy and the associated changes and/or upgrades to existing campus infrastructure. The three modeled long-term alternatives include: biomass gasification for steam production at Centennial and Centennial Biomedical campuses, solid waste plasma gasification with cogeneration at Centennial and Centennial Biomedical campuses, and a replacement energy source for all of the natural gas currently used on main campus (**Appendix E, Figures 10-12**).

5.3 Role of Offsets

According to the carbon management hierarchy discussed previously, offsetting of GHG emissions ideally occurs after all other abatement opportunities have been realized. The ACUPCC defines carbon offsets as a real reduction, sequestration, destruction, or avoidance of GHG emissions that must be measured and quantified, and originate from projects or activities outside the boundary of a regulatory program or an entity's carbon foot print[5]. "Offsets are created through financial support of projects that reduce the emission of greenhouse gases."

"Offsets should be regarded as one GHG emissions investment opportunity among a diverse portfolio of options that will contribute to North Carolina State University achieving climate neutrality over the long term[6]. " Many other college and university climate action plans are utilizing offsets to help reach their climate neutrality commitment. Alternately, NC State has chosen not to place the focus on offsets but rather to rely on the impact of near term strategies and the ability of future technologies and alternatives to provide the opportunities for reaching climate neutrality. This approach not only helps prioritize the near term strategies over offsets, but also allows the University to more easily take advantage of utilizing emerging technologies.

[5]*The American College and University Presidents Cimate Commitment document, "investing in Carbon Offsets: Guidelines for ACUPCC Institutions" November 2008 v1.0*
[6]*Energy Strategies document "Role of Offets in Meeting North Carolina State University's Climate Neutrality Commitment, June 2010*

6. CONTINUING THE JOURNEY FORWARD

The creation of the CAP is one of the first steps on the journey towards climate neutrality. The University now has a road map for which to help guide decision making and planning into the future. However, the implementation of the proposed strategies and goals are ultimately the means for reducing GHG emissions at NC State.

The CAP projects approximately a 20% GHG reduction from 2008 emissions by 2015 based on the near-term portfolio implementation. This 20% reduction is equal to 84,111 MTCDE over the next five years. **Figure 5** details the percent contribution by wedge to the total reduction in 2015. Similar to the overall reduction portfolio, the focus of the next five years is on energy conservation and fuel mix and renewables.

NC State is making significant headway in many of the near term strategies. A large number of projects and programs are already being developed and implemented. **Table 3** provides examples of projects and programs that are currently underway in each of wedge groups. These success stories are proof that NC State's efforts are moving in the right direction and already reducing GHG emissions. Development of additional initiatives continue as a part of the overall sustainability planning and within the daily operations of the University. Each of these efforts is moving NC State closer to climate neutrality.

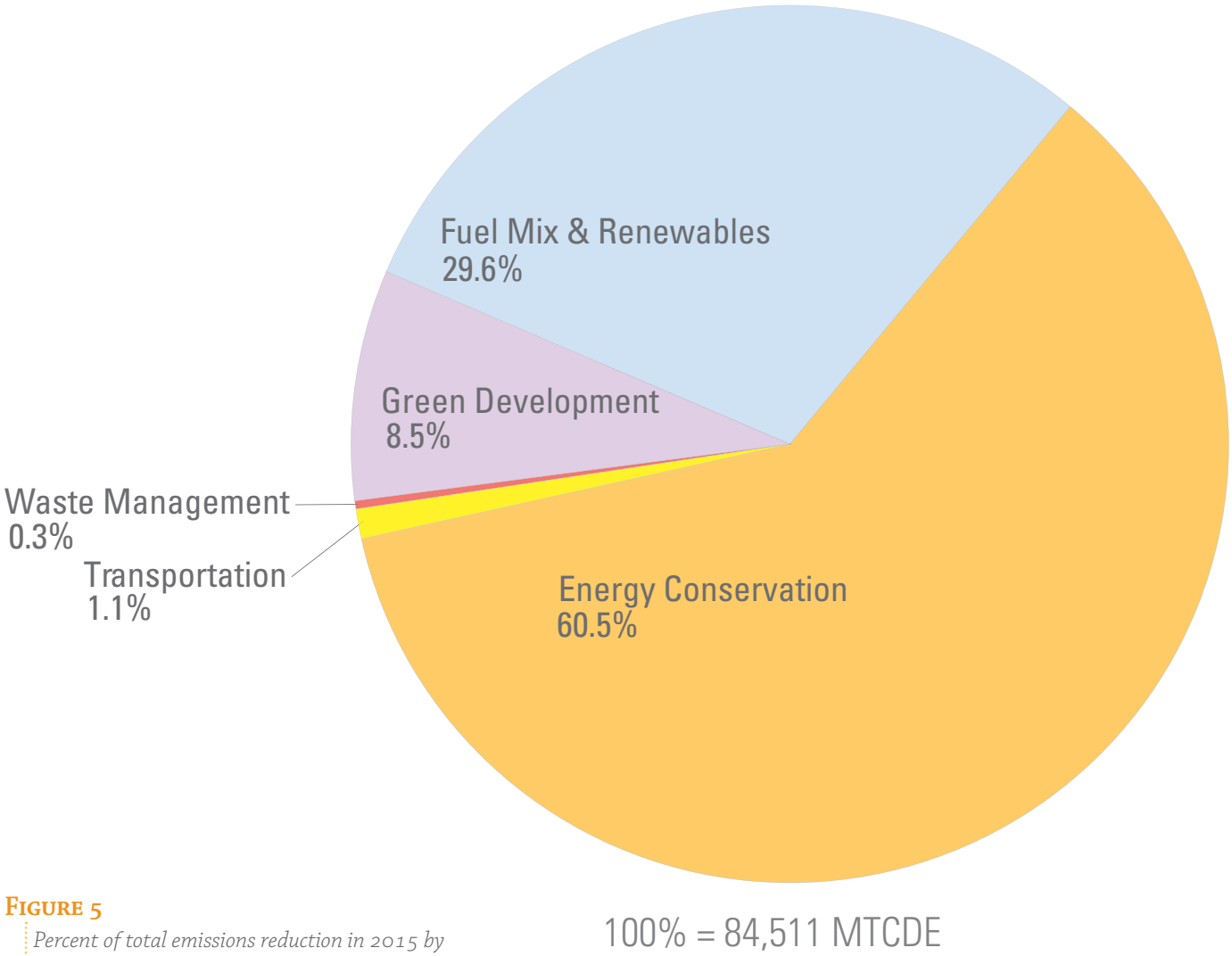

Figure 5

Percent of total emissions reduction in 2015 by wedge of a 84,511 MTCDE total reduction.

The CAP, along with the Strategic Energy Management Plan, are supporting documents for the Sustainability Strategic Plan. All three plans compliment each other. The five-year sustainability strategies were the basis for the CAP strategies and each of the 41 focus areas of the Strategic Energy Management Plan are directly tied to the CAP. A streamlined tracking of progress moving forward ensures goals are met on a broad sustainability scale. Implementation measures will include establishing specific tactical steps, responsible parties and performance metrics.

The CAP is not a static document. Rather, it allows for updates and changes over time. As new GHG inventories are performed, new technologies developed and new opportunities available, the strategies and goals within the plan will change. Detailed revisions to the technical analysis and modeling are required in the future in order to continue the CAP as a usable tool. The first iteration of the plan created a framework for planning and progressing NC State towards climate neutrality.

Table 3

Examples of projects and programs currently underway.

Wedges	Projects & Programs
GREEN DEVELOPMENT	**Various green building** *initiatives such as the US Green Building Council's Leadership in Energy and Efficient Design (LEED) Silver buildings are both under construction and in design.* **Efforts towards improved** *space planning continue with the addition of a staff position to help analyze and implement space utilization standards.*
ENERGY CONSERVATION	**A variety of** *energy conservation measures (ECMs) are the result of a 13 building performance contract.* **A major campaign**, *called 'Change Your State' is launching targeting energy conservation on campus through behavior change.*
FUEL MIX & RENEWABLES	**Plans for installing** *a combined heat and power system at the Cates Plant are underway.* **Solar Photovoltaics** *planned for installation at the Centennial Campus Keystone Science Center and the Flex Laboratory Building.* **A solar domestic** *hot water system recently installed at Carmichael Gymnasium.*
TRANSPORTATION	**A comprehensive bike** *and pedestrian plan is being developed for the University.* **A bicycle rental** *program, called WolfWheels recently launched.*
WASTE MANAGEMENT	**Walkway recycling bins** *are being added across campus.* **Food waste is** *now being composted at all University dining halls.*

7. CULTIVATING CHANGE

Though many of the strategies proposed to mitigate carbon emissions on campus require physical modifications to buildings and infrastructure, an equally important goal is the need for a culture change related to how the campus community views natural resources. The behavior change required to reduce GHG emissions will be part of a larger culture change that embraces sustainability. The vision for growing the intellectual and scholastic scope of the University while using fewer resources is within the grasp of current and emerging technologies, but will require fundamental change that reflects new priorities and actions. All activities, programs, and investments advance the capacity of the University to accomplish its future missions. Therefore, in the broadest sense, the University commits to sustainability with all of its actions. Including sustainability at the core of the University's identity will require creating a new culture of sustainability. The new culture is guided by the principles below.

Guiding Principles for the Culture of Sustainability

1. *The Provost and Vice Chancellor for Finance and Business are responsible for guiding activities and investments to advance sustainability.*
2. *Planning for sustainability involves students, faculty members, and staff members.*
3. *Planning for sustainability includes diversity including ethnicity, race, national origin, age, gender, sexual orientation, socioeconomic background, religion, and disability.*
4. *All viewpoints, suggestions, and opinions are welcome and treated with respect.*
5. *The University advances sustainability with fiscal responsibility and social equity.*
6. *The University advances sustainability with activities and investments that reflect the value of the institution, recognizing that costs provide benefits that extend far beyond its campus.*
7. *All campus development, growth, and modification will include sustainability as a factor.*
8. *Advancing sustainability includes University-wide commitments as well as commitments of individual action.*
9. *Sustainability planning exemplifies the interdependence of working across multiple systems, fields, and sectors.*

Creating the new culture of sustainability requires recognition of a new community at NC State. Historically, the University operated with students, faculty members, and staff members as largely independent groups. Each of the groups has different needs, responsibilities, interests, and values. Over the past several years, the need to advance sustainability has brought students, faculty members and staff members together to form the new foundations for a University community capable of planning for the future.

8. MAINTAINING MOMENTUM

In many ways, the end of a successful planning project is marked by a realization that the effort is already moving in the right direction. This notion speaks to the fact that the progress made while creating a plan is often as important as the plan itself. Together, the Sustainability Strategic Plan, the Strategic Energy Management Plan and the CAP have opened the door to the opportunities for and the successes in reducing NC State's climate impact.

NC State is indeed making strides toward reducing GHG emissions. The GHG reduction portfolio produced by the CAP contained numerous projects and initiatives that were already underway. The CAP and supporting information not only bolsters these efforts but provides an additional resource for making informed decisions well into the future. Climate neutrality by 2050 is possible through maintaining momentum and realizing reductions today while continuing to plan for the future.

The road to neutrality requires NC State to advance the strategies within the GHG reduction portfolio at every opportunity. Comprehensive analysis revealed that the portfolio offers cost-effective and feasible solutions to achieving real reductions in GHG emissions. The near-term portfolio in the CAP could result in approximately a 20% GHG emissions reduction from 2008 levels by 2015. The near-term strategies within the green development, energy conservation, fuel mix and renewables, transportation, and waste management wedges create a framework for continued GHG reduction at NC State.

In addition to physical and operational modifications, a culture change related to how the campus community views natural resources is required. Including sustainability at the core of the University's identity will require creating a new culture of sustainability. This culture is guided by principles that place sustainability as a priority at NC State. In turn, creating the new culture of sustainability requires recognition of a new community at the University. This community operates with students, faculty members and staff members as a collaborative community who plans for the sustainable future of NC State.

Though NC State is gaining momentum in the right direction, a challenging road lies ahead in order to reach the goal of climate neutrality by 2050. Changes must occur in every aspect of how the university carries out its mission of learning, discovery, and engagement. The University must build on successes and continually work to find creative solutions to current and emerging issues. The Climate Action Plan is the roadmap to lead NC State towards climate neutrality.

Appendices

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Lisa Eberhart
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Pete Evans
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Darren Fallis
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Rob Farrell
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B. TERMS AND ACRONYMS

ACUPCC	American College and University Presidents' Climate Commitment.
BAU	Business As Usual
CAP	Climate Action Plan
GHG	Greenhouse Gases
MTCDE	Metric Tons of Carbon Dioxide Equivalent
PEC	Progress Energy Carolinas, Inc.
USGBC LEED	United States Green Building Council Leadership in Energy and Environmental Design
Abatement	A lessening or reduction
Portfolio	A collection of strategies
Scopes	Categorization of greenhouse gases (Scope 1 emissions are direct emissions from the University and includes items such as fuels and refrigerants. Scope 2 emissions are indirect emissions from purchased electricity, which in NC State University's case is from PEC. Scope 3 emissions are also indirect emissions from activities such as commuting, air travel and waste disposal)
Wedges	A common way of grouping similar carbon abatement strategies

C. BUSINESS AS USUAL DRIVERS

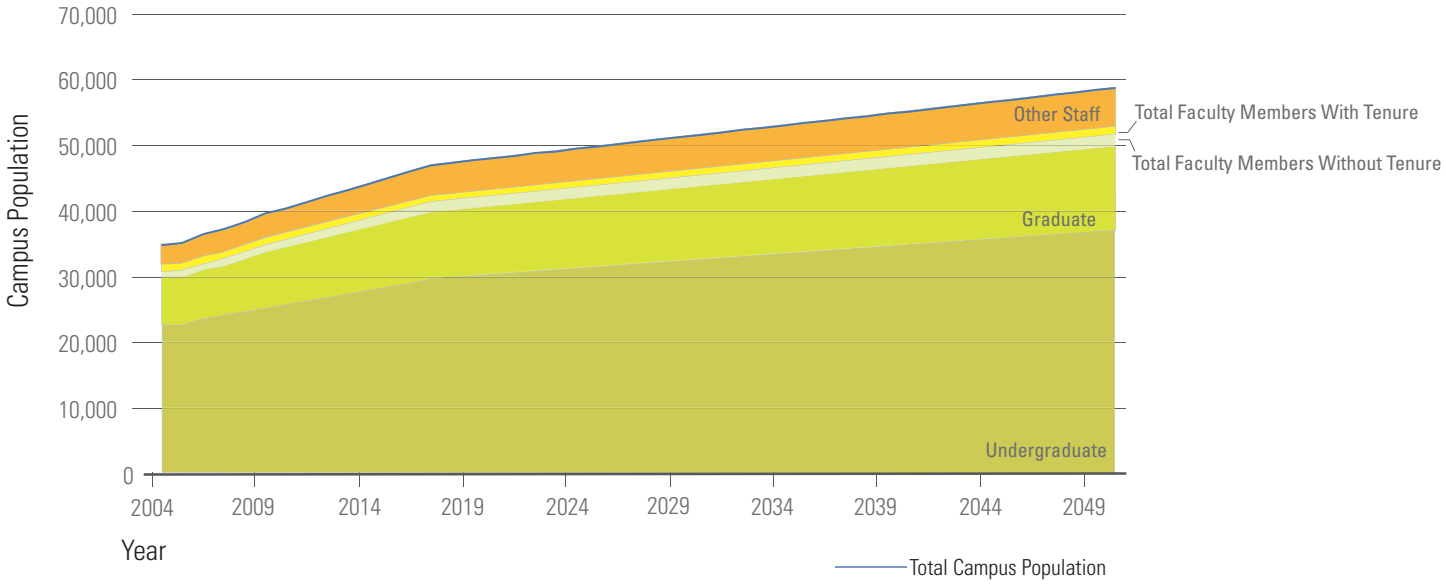


Figure 6

Total campus population forecasted through 2050.

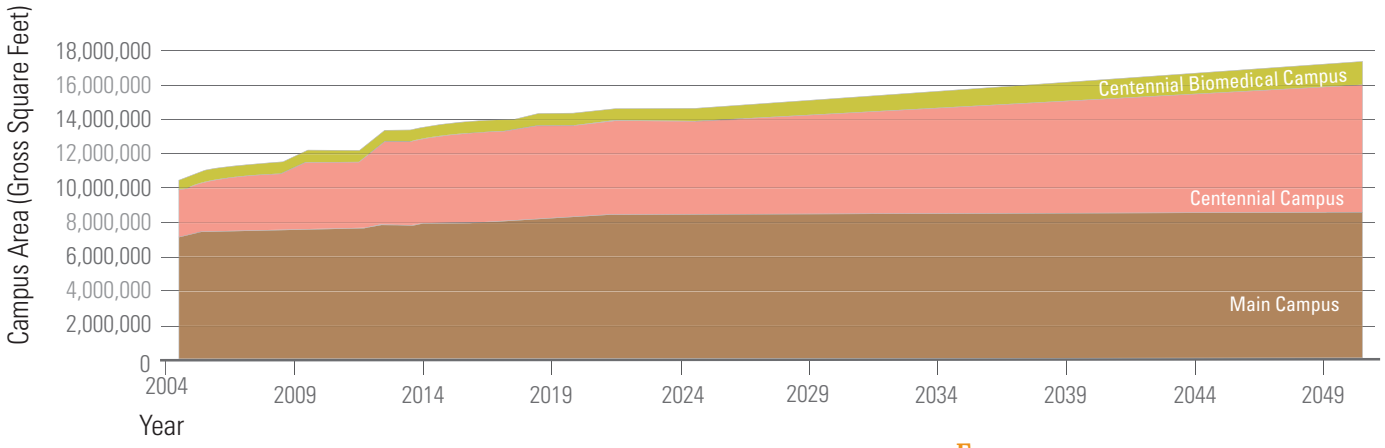
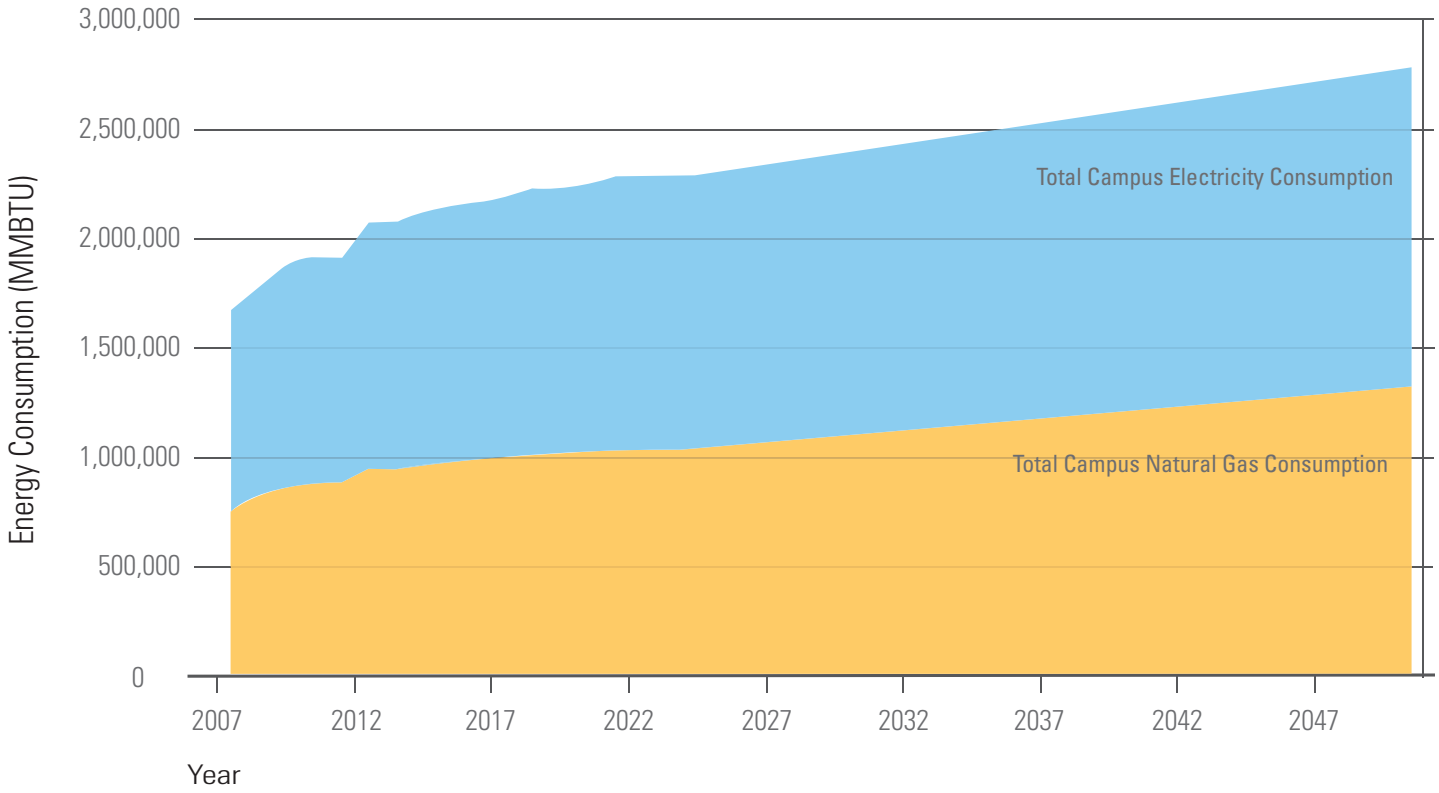


Figure 7

Total campus area growth forecasted through 2050.

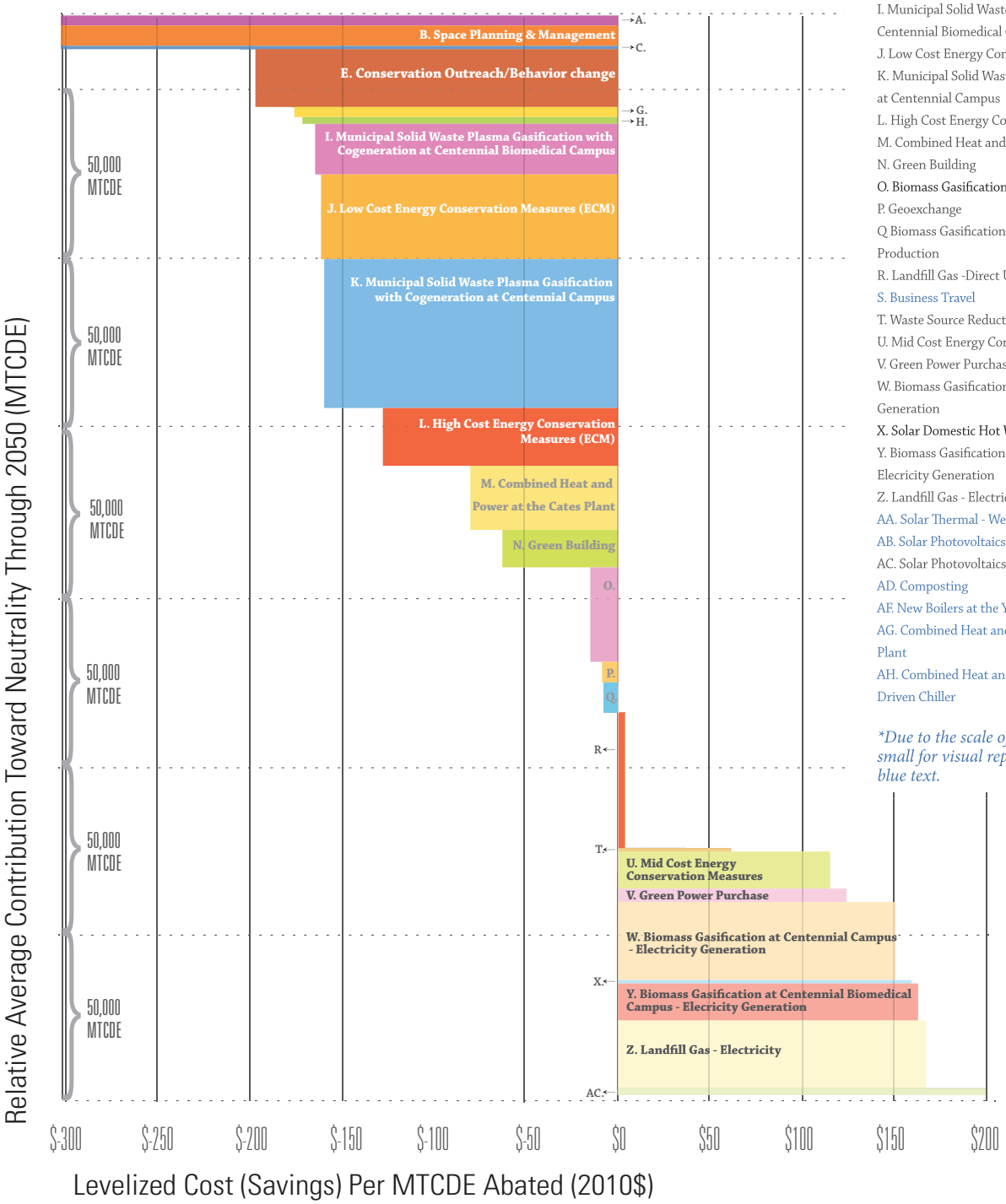


MMBTU = A thousand thousand British Thermal Units

Figure 8

Total campus energy consumption forecasted through 2050.

D. ABATEMENT CURVE



KEY

A. Improved Commuting
B. Space Planning & Management
C. Campus Fleet
D. Grounds Management
E. Conservation Outreach/Behavior change
F. Waste Diversion
G. Electric Chiller at the Cates Plant
H. Green IT
I. Municipal Solid Waste Plasma Gasification with Cogeneration at Centennial Biomedical Campus
J. Low Cost Energy Conservation Measures (ECM)
K. Municipal Solid Waste Plasma Gasification with Cogeneration at Centennial Campus
L. High Cost Energy Conservation Measures (ECM)
M. Combined Heat and Power at the Cates Plant
N. Green Building
O. Biomass Gasification at Centennial Campus - Steam Production
P. Geoexchange
Q Biomass Gasification at Centennial Biomedical Campus - Steam Production
R. Landfill Gas -Direct Use
S. Business Travel
T. Waste Source Reduction
U. Mid Cost Energy Conservation Measures
V. Green Power Purchase
W. Biomass Gasification at Centennial Campus - Electricity Generation
X. Solar Domestic Hot Water
Y. Biomass Gasification at Centennial Biomedical Campus - Elecricity Generation
Z. Landfill Gas - Electricity
AA. Solar Thermal - West Chiller Plant
AB. Solar Photovoltaics - Buildings
AC. Solar Photovoltaics- Parking Decks
AD. Composting
AF. New Boilers at the Yarbrough Plant
AG. Combined Heat and Power at Centennial Campus Utility Plant
AH. Combined Heat and Power at Centennial Campus and Steam Driven Chiller

**Due to the scale of the graph, some sections are too small for visual representation. These are denoted by blue text.*

Figure 9

The abatement curve illustrates the potential GHG reduction and value of the 30 modeled strategies for the CAP. The x-axis represents the levelized cost or savings per MTCDE abated of each strategy and the y-axis represents the relative average contribution toward neutrality. Thus, the items on the left save money and reduce emissions while those on the right cost money to reduce emissions. The strategies with the most GHG reduction potential are illustrated with the thickest bars.

E. LONG-TERM PORTFOLIO

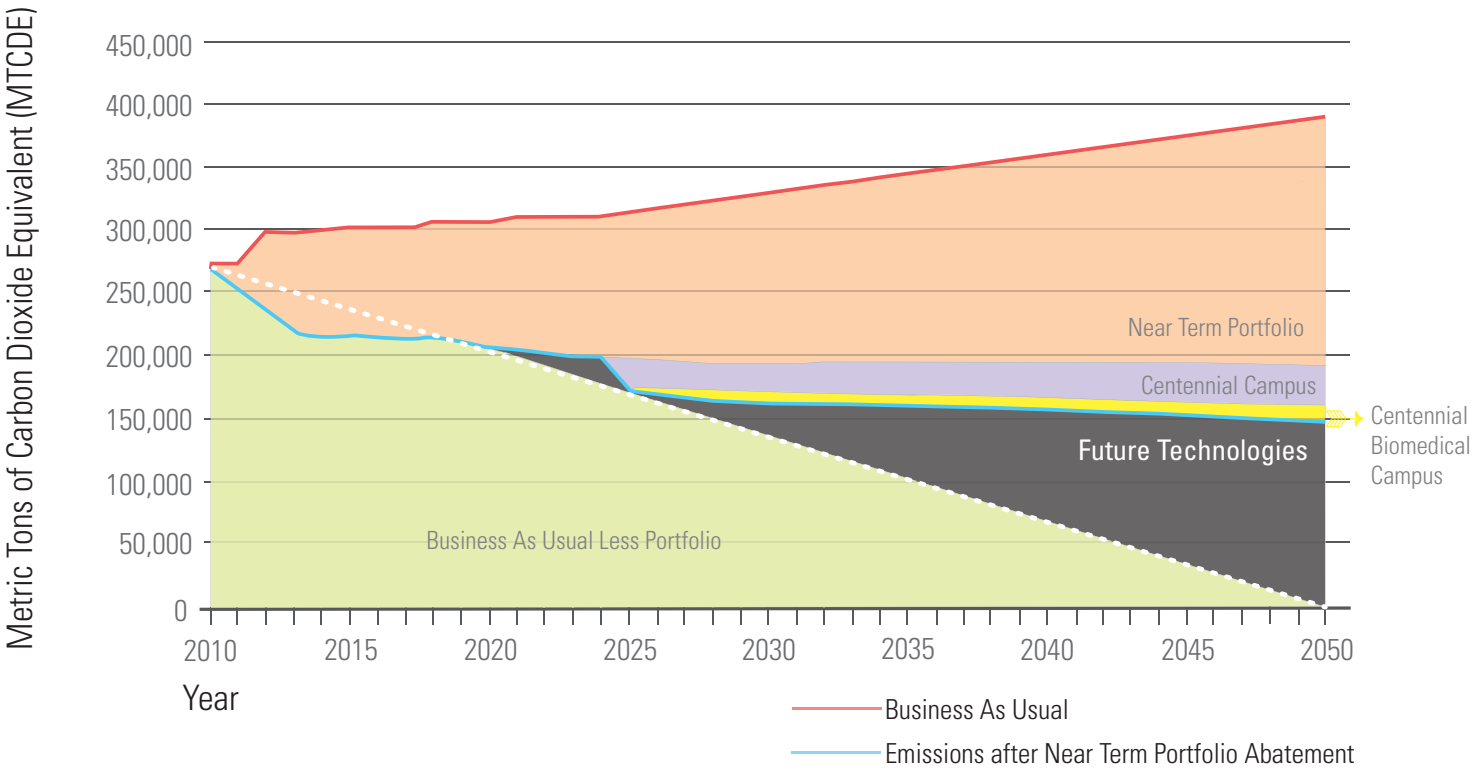


Figure 10
Biomass Gasification for Steam Production

Figure 10 portrays the GHG reduction potential if biomass gasification is implemented on Centennial and Centennial Biomedical Campus in approximately 2025. Biomass gasification is a thermal conversion technology where a solid biomass fuel is converted into a combustible gas known as synthesis gas (syngas). In this case, it is assumed that the primary product of using the syngas would be steam with a small amount of electricity cogenerated using a steam turbine.

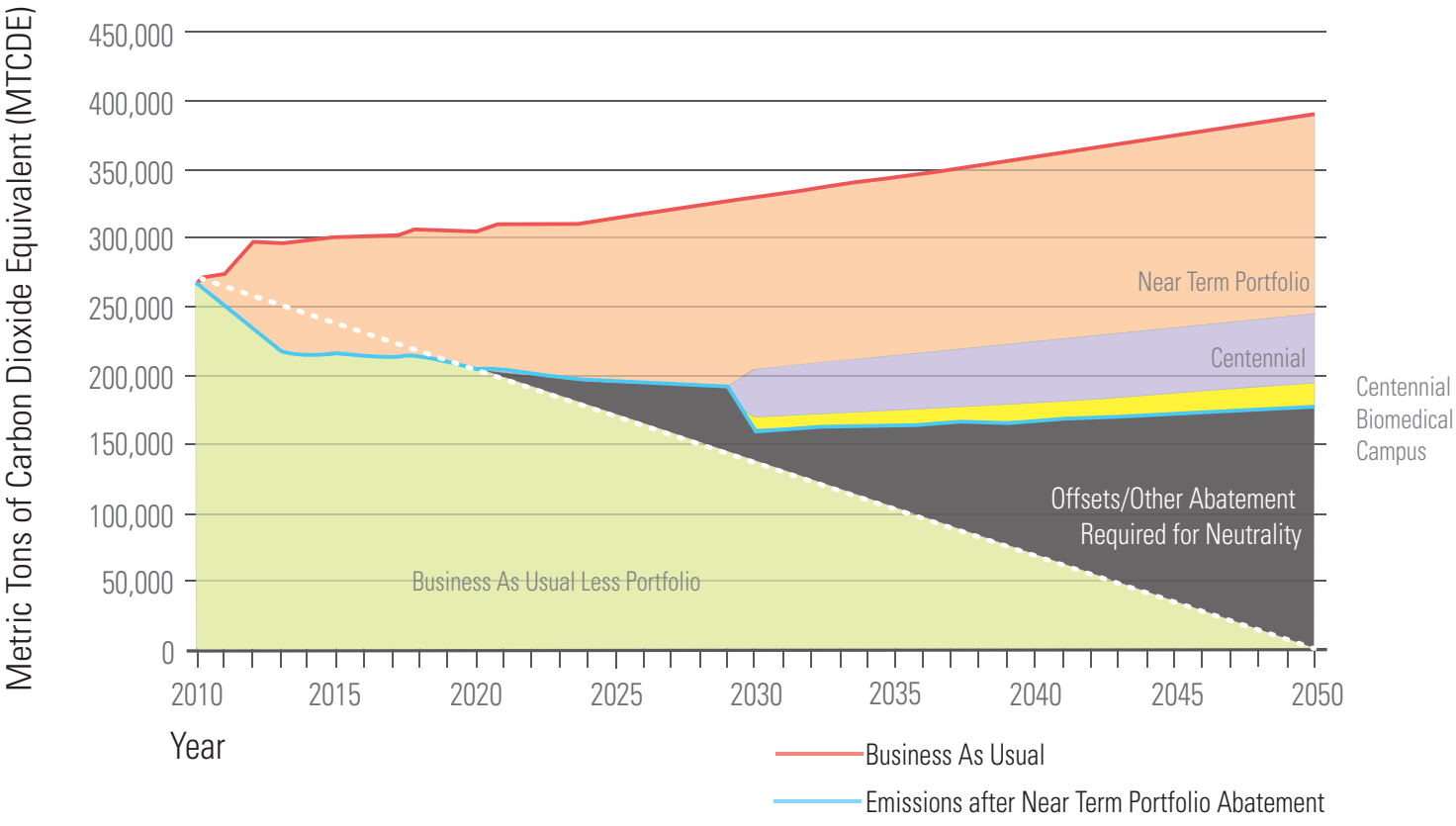


Figure 11
Solid Waste Plasma Gasification with Cogeneration

Figure 11 portrays the GHG reduction potential if municipal solid waste (MSW) plasma gasification is implemented on Centennial and Centennial Biomedical Campus in approximately 2030. Plasma gasification of MSW is similar to biomass gasification in that the fuel, MSW, is heated to create a syngas. Organic materials are gasified to produce a usable syngas and residual materials such as inorganics and heavy metals are immobilized into a rock-like vitrified mass or slag. The syngas and residual heat from the process can be used in a series of heat recovery steam generators and turbines to produce both steam and electricity for use on campus.

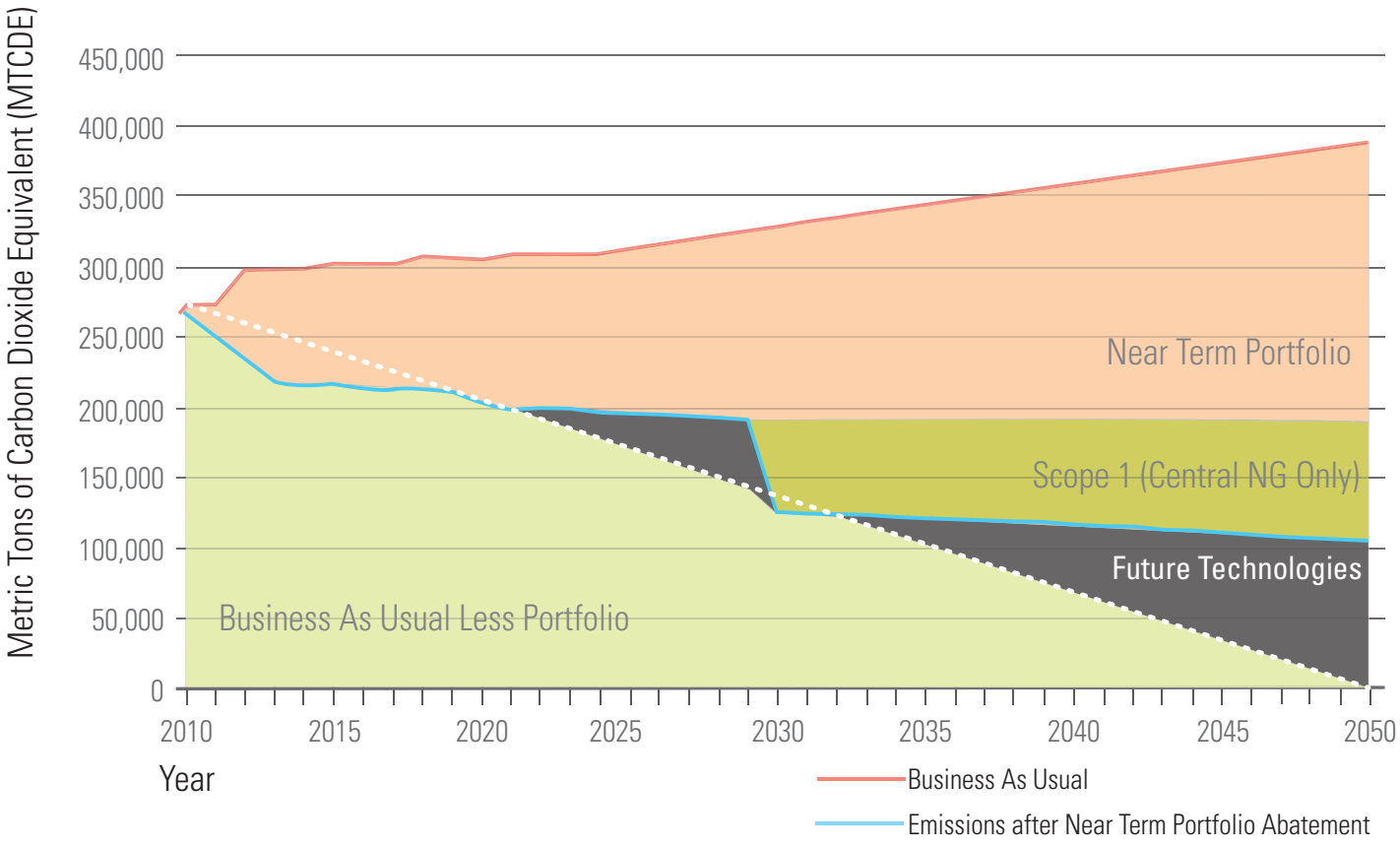


Figure 12
Scope 1 (Natural Gas on Main Campus only) Reduction Long-term Portfolio Path

The energy supply options analyzed for this initial version of the CAP do not, for the most part, address any significant decrease in the natural gas combusted for steam production on main campus. While renewable energy options such as biomass gasification and plasma gasification of MSW were considered for Centennial and CBC campuses, these alternatives were not modeled for potential implementation on main campus due to such factors as plant location, space availability, fuel delivery traffic, and the overall scale required of such a project to replace natural gas usage on main campus. Natural gas combustion for steam and/or power production will be a large portion of the University's potential GHG footprint in the future and this source of emissions cannot be ignored.

Figure 12 shows the projected GHG emissions from natural gas combustion on main campus to illustrate the magnitude of these emissions relative to the overall footprint and convey the importance of making efforts to reduce these emissions over time. Continued monitoring of technologies with the potential to replace natural gas-based steam and power production at NC State is required. Those technologies will be considered as they become technically feasible.

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