TCNJ

THE COLLEGE OF NEW JERSEY

CLIMATE ACTION PLAN

FEBRUARY 2016

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EXECUTIVE SUMMARY

A presidential commitment to smart investment and shared governance have allowed The College of New Jersey (TCNJ, the College) to reduce successfully its greenhouse gas (GHG) footprint over the last decade. President Gitenstein's 2007 signing of the American College & University Presidents Climate Commitment (ACUPCC) renewed the College's commitment to GHG reduction. Working closely with several campus constituencies, especially the Facilities department, the President's Climate Commitment Committee (PC3) designs and implements a number of projects to increase environmental efficiency and awareness on campus.

The College has achieved reductions in net GHG emissions. The figure below summarizes finding shown in the carbon inventory in section one. Much of this reduction comes from an increase in

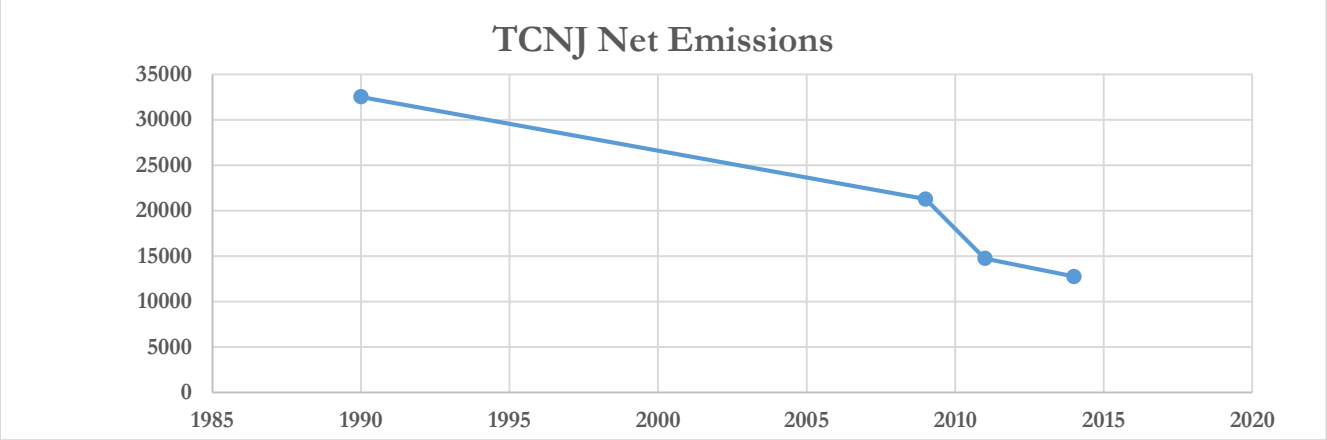

Figure 1- TCNJ Net Carbon Emissions Over Time

carbon offsets from The College's tree canopy, with some fluctuations in scope on, two, and three emissions (see page 12). While the size and power demand of TCNJ has grown, efficiency gains and carbon offsets have led to consistently lower net emissions.

Three sections describe past, current, and future initiatives to reduce GHG emissions across three types of sources: energy usage and facilities; transportation; and the reduction of consumption, waste and water usage. The following section describes past and current initiatives to bring issues of environmental sustainability into the curriculum, research and engagement of constituencies on campus and beyond. Table 1 (starting on page 32) summarizes new and future projects in all four areas.

Comparing TCNJ's success across all four areas, most improvements have been made in the areas of energy use, including the construction of more efficient facilities through smart investment policies. Although such outlays provide a higher return in the long term, the initial investment in green technologies currently can be difficult for a public institution of higher education. Nonetheless, energy and facilities represent the largest emission source for TCNJ and The College continues to fulfill ardently its commitment to reducing emissions. Creative initiative in other areas require the combined participation of students, staffs, and faculty. Some of these programs may prove to be models of cost-effective greenhouse gas reduction projects for other organizations. The emphasis on environmental

sustainability across the curriculum and in student life provides a supportive context for such projects. Although as a small institution TCNJ does not support an academic major in environmental sustainability, this goal is interwoven across the curriculum, co-curricular activities, faculty research, and community outreach. While not always typical, TCNJ's climate strategy has proven quite successful.

INTRODUCTION

A presidential commitment to smart investment and shared governance have allowed The College of New Jersey (TCNJ, the College) to reduce successfully its greenhouse gas (GHG) footprint over the last decade. President Gitenstein's 2007 signing of the American College & University Presidents Climate Commitment (ACUPCC) renewed the College's commitment to GHG reduction. This plan documents actions taken to date as well as future initiatives to meet GHG reduction goals.

TCNJ has a strong commitment to addressing climate change. However, as a public institution, The College needs to find initiatives to reduce GHG that are fiscally responsible. Nationally, institutions of higher education have confronted daunting changes in fiscal structure. Beyond that, The College commits itself to providing access to a diverse population and fears that added tuition costs from environmental projects would work against values of diversity and broad access. The College embraces progress in environmental progress yet must balance that against other valuable social objectives.

Using the academic advances in the study of environmental economics, engineering, and policy, the College has created programs and structured investments that reduce or mitigate GHC while also saving money and resources. To a large degree, reducing pollution is reducing waste. For example, energy savings programs in the dorms decrease The College's carbon footprint while also realizing substantial financial savings. Facilities are built with energy-saving features that realize long-term savings from a small initial investment, yielding a high rate of return. Moreover, many of the initiatives described below target the behavior of students, staff and faculty in a way where thrift and pollution reduction are complementary.

This document provides a summary of current initiatives and plans for The College's GHG reductions. It begins with a description of the institution. Next it describes the actors involved in carrying out the AUCCP objectives and quantifies current GHG emissions. A discussion of current and future projects across several areas follows.

The College of New Jersey is a highly selective institution that has earned national recognition for its commitment to excellence. Founded in 1855, TCNJ has become an exemplar of the best in public higher education and is consistently acknowledged as one of the top comprehensive colleges in the nation. TCNJ currently is ranked as one of the 75 "Most Competitive" schools in the nation by Barron's Profiles of American Colleges and is rated the No. 1 public institution in the northern region of the country by U.S. News & World Report. TCNJ was named the #10 value in public higher education by the Princeton review in 2009 and, in 2006, the College joined an elite group of institutions when it was awarded a Phi Beta Kappa chapter. Fewer than 10 percent of the nation's colleges and universities share this honor.

Figure 2-- The College of New Jersey viewed from above

THE MISSION OF THE INSTITUTION

Founded in 1855 as the New Jersey State Normal School, TCNJ is primarily an undergraduate and residential college with targeted graduate programs. TCNJ's exceptional students, teacher-scholars, staff, alumni, and board members constitute a diverse community of learners, dedicated to free inquiry and open exchange, to excellence in teaching, creativity, scholarship, and citizenship, and to the transformative power of education in a highly competitive institution. The College prepares students to excel in their chosen fields and to create, preserve and transmit knowledge, arts and wisdom. Proud of its public service mandate to educate leaders of New Jersey and the nation, The College will be a national exemplar in the education of those who seek to sustain and advance the communities in which they live.

ACADEMIC PROGRAMS

A strong liberal arts core forms the foundation for a wealth of degree programs offered through TCNJ's seven schools—Arts & Communication; Business; Humanities and Social Science; Education; Science; Nursing, Health, and Exercise Science; and Engineering. The College is enriched by an honors program and extensive opportunities to study abroad, and its award-winning First-Year Experience and freshman orientation programs have helped make its retention and graduation rates among the highest in the country.

THE CAMPUS

Known for its natural beauty, the College's main campus is set on 289 tree-lined acres in suburban Ewing Township (see map). The College has 40 major buildings, including a state-of-the-art library; 14 residence halls that accommodate 3,800 students; an award-winning student center; more than 30 academic computer laboratories; a full range of laboratories for nursing, microscopy, science, and technology; a music building with a 300-seat concert hall; and a collegiate recreation and athletic facilities complex. TCNJ has a full-time undergraduate enrollment of approximately 6,500 students (95 percent from New Jersey).

Figure 3--Phelps Hall at The College of New Jersey, a new "green" residence hall.

STUDENT LIFE

The College of New Jersey encourages students to expand their talents and skills through more than 150 organizations that are open to students. These groups range from performing ensembles and professional and honor societies to student publications, Greek organizations, as well as intramural and club sports. The College also offers numerous leadership opportunities through the Student Finance Board, Student Government Association, and Residence Hall Government to name a few.

PHYSICAL PLANT HISTORY

The College of New Jersey's reaches back to 1855 when it was established by the state legislature as the New Jersey State Normal School. In 1932, The College of New Jersey (known then as Trenton State Teachers College) was mostly commuters and the physical plant was less than 1,000,000 gross square feet (GSF). Buildings were predominantly masonry (brick) with operable single glazed windows.

Heating was provided by coal-fired stoker steam boilers in a central plant. There was no air conditioning. PSE&G, the local utility, provided electric power and the College had its own wells and waste water treatment plant. By 1990 TCNJ had approximately 30% resident students. The physical plant had grown to 1,637,000 GSF and included new academic and residential buildings. Air conditioning for academic buildings was becoming standard. PSE&G continued to supply the college with electric power and natural gas. The central plant was now fueled by #6 fuel oil stored in large underground tanks (UST's). Water was supplied by Trenton Water Company and the Ewing Lawrence Municipal Utility Authority is providing wastewater treatment.

By 2000, TCNJ had grown to 2,560,000 GSF. Over 40% of the students resided on campus. Demands for air conditioning, large volumes of air changes for indoor air quality and inoperable windows became predominant. The College had made the decision to install its own cogeneration system in the central plant and was now producing 85%-90% of its electric power on site. Natural gas on an interruptible basis with #2 fuel oil back-up is the major source to this day.

The undergraduate full-time student population has risen to 6500, of which approximately 3,800 (58%) are housed on campus, and comprises 3,022,094 GSF with a mixture of buildings that date from the original 1930 period to brand new residence life buildings coming online in 2009. With plans to add other new buildings between now and 2021, it is likely that the campus will continue to grow at a steady rate in GSF for the foreseeable future. This raises one of the fundamental questions of carbon neutrality, how does an entity such as TCNJ continue to physically grow while reducing or eliminating its carbon footprint?

TCNJ'S CLIMATE COMMITMENT

Dr. Gitenstein, President of the College, signed the American College and University Presidents Climate Commitment (ACUPCC), one of the first college presidents in New Jersey to do so. The Presidents Climate Commitment is a voluntary initiative organized through the American College and University organization. With over 800 colleges and universities nationally signed on to the commitment, TCNJ is part of a growing community of educational institutions that "are deeply concerned about the unprecedented scale and speed of global warming and its potential for large-scale, adverse health, social, economic and ecological effects."

Further and perhaps more importantly, by signing the President's Climate Commitment TCNJ has made it clear that they, "believe colleges and universities must exercise leadership in their communities and throughout society by modeling ways to minimize global warming emissions, and by providing the knowledge and the educated graduates to achieve climate neutrality. Campuses that address the climate challenge by reducing global warming emissions and by integrating sustainability into their curriculum will better serve their students and meet their social mandate to help create a thriving, ethical and civil society. These colleges and universities will be providing students with the knowledge and skills needed to address the critical, systemic challenges faced by the world in this new century and enable them to benefit from the economic opportunities that will arise as a result of solutions they develop." Upon signing of the commitment, the College obligated itself to take several specific steps to fulfill the requirements. These include the following:

1. Initiate the development of a comprehensive plan to achieve climate neutrality as soon as possible.
   - Within two months of signing, create institutional structures to guide the development and implementation of the plan. (Complete)
   - Within one year of signing, complete a comprehensive inventory of all greenhouse gas emissions (including emissions from electricity, heating, commuting, and air travel) and update the inventory every other year thereafter. (Complete)
   - Within two years of signing this document, develop an institutional action plan for becoming climate neutral, which will include (In-Progress):
   - A target date for achieving climate neutrality as soon as possible.
   - Interim targets for goals and actions that will lead to climate neutrality.

- Actions to make climate neutrality and sustainability part of the curriculum and other educational experiences for all students.
- Actions to expand research or other efforts necessary to achieve climate neutrality.
- Mechanisms for tracking progress on goals and actions.

2. Initiate two or more of the following tangible actions to reduce greenhouse gases while the comprehensive plan is being developed.
   - Establish a policy that all new campus construction will be built to at least the U.S. Green Building Council's LEED Silver standard or equivalent.
   - Adopt an energy-efficient appliance purchasing policy requiring purchase of ENERGY STAR certified products in all areas for which such ratings exist. (Policy Implemented)
   - Establish a policy to offset emissions from air travel paid for by our institution.
   - Encourage use of and provide access to public transportation for faculty, staff, students and visitors.
   - Within one year of signing, begin purchasing or producing at least 15% of institution's electricity consumption from renewable sources.
   - Establish a policy or a committee that supports climate and sustainability shareholder proposals at companies where institution's endowment is invested.
   - Participate in the Waste Minimization component of the national RecycleMania competition, and adopt 3 or more associated measures to reduce waste.

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

   The College has completed the first round of climate commitment obligations including:
   - Preparing a greenhouse gas inventory of the institution every three years;
   - A commitment to purchase only Energy Star® rated equipment and appliances at the College where such equipment exists;
   - The creation and implementation of initiatives to reduce emissions from transportation. These include surveys, carpooling/ridesharing programs and information on lower-impact transportation options for students, staff, and faculty;
   - Education to members of the campus community about the magnitude and impact of waste in energy use, food supply, and other areas;
   - The College has engaged an architectural/engineering consultant to prepare a long-term climate neutrality plan to detail the cost, process and time table in which the College can achieve net zero carbon emissions and climate neutrality for its operations.
   -

THE PRESIDENTS CLIMATE COMMITMENT COMMITTEE (PC3)

The Presidents Climate Commitment Committee (PC3) consists of faculty, staff and students working together to assess periodically and continually decrease The College's GHG footprint. The shared governance structure of the committee improves its ability to collect and disseminate information, as well as provide creative solutions to GHG reduction. PC3 completes a greenhouse gas inventory for the College every three years, with the 2015 inventory being the most recent. After complying with the initial obligations of the American College and University Presidents Climate Committee (ACUPCC), PC3 embarked on numerous initiatives across different issue areas.

The membership of the PC3 includes representatives from across campus from a variety of constituencies. PC3 solicits new student, staff, and faculty members in response to changing challenges and opportunities. The current membership of the PC3 consists of:

- Curt Heuring (Co-chair), Vice President for Administration
- Brian Potter (Co-chair), Associate Professor of Political Science
- Jack Baldwin, Bonner Scholar, PC3
- Aphrael Boltas, Bonner Scholar, PC3 Deputy Site Leader
- Liz Eisenhauer, Environmental Club Vice-President
- Winnie Fatton, Project Manager, Sustainable Jersey
- Michael Horst, Associate Professor of Civil Engineering
- Tyler Holzer, Bonner Scholar, PC3 Deputy Site Leader
- Grace Hostetter, Bonner Scholar, PC3 Deputy Site Leader
- Rita Mary King, Math and Science Tutoring Coordinator
- Nathan Magee, Associate Professor of Physics
- Eric Mauro, Environmental Club President
- Megan Nicholson, CEL Coordinator Environment and Public Health, Bonner Center
- Joe O'Brien, Network and Technical Services, Information Technology
- Karen Roth, Director of Dining Services and Students Affairs Development Office
- Lori Winyard, Director of Energy and Central Utilities
- Kate Yazvjian, Bonner Scholar, PC3 Deputy Site Leader

The PC3 committee meets once a month during the academic year.

Through its website (http://climate.pages.tcnj.edu/) PC3 offers to the college community advice on how to minimize GHG emissions, as well as the importance of such work. PC3 initiatives and contact information can also be found on the website.

Funding for the committee is quite modest. Further, almost all of the PC3 budget is committed to membership fees (such as that for the ACUPCC) or Bonner scholarships, leaving a discretionary budget of less than two thousand dollars.

TCNJ'S CARBON FOOTPRINT AND GHG INVENTORY

The College has reduced its net emissions over time, as seen in the net emissions listed on the next page. After discussing TCNJ's carbon inventory, this section outlines the GHG reduction action plan and reduction strategies.

The majority of the emissions are from the College's central plant, which includes a cogeneration combined heat and power system, steam boilers, and chillers. The cogeneration plant currently produces 85% to 90% of the College's electricity. The central plant contributes 68% of the College's greenhouse gas footprint in natural gas consumption, and is the largest contributor of greenhouse gas emissions. The next largest contributor is commuting at 20%. The third largest contributor is purchased electricity from Public Service Electric and Gas (PSE&G), primarily associated with building use but also for site lighting. Combined, these three areas account for 95% of the entire campus greenhouse gas footprint. The remaining 5% of the campus greenhouse gas footprint is associated with air travel, refrigerants, fuel oil usage, fleet gasoline usage, and landfill disposal.

Without the central plant system, the College would be forced to purchase all of its electricity from PSE&G on the Pennsylvania/Jersey/Maryland (PJM) grid. This would increase the total campus carbon footprint by approximately 47%. It is clear the solution to carbon neutrality is not to shut down the central plant, albeit the largest contributor. That would only exacerbate the problem. The key to neutrality is a complex undertaking, which will involve a holistic approach, both short and long term.

Tree carbon sequestering plays an integral role in offsetting greenhouse gases. A formal program has not begun, but TCNJ used a USEPA metric for the GHG inventory that estimates that our wooded properties equate to annual greenhouse gas savings of 24,771 eMTC02 per year (2009 did not include all of our wooded properties, thus the increase in this offset in 2011 and 2014).

EMISSION SCOPES

To help delineate direct and indirect emission sources, three "scopes" (scope 1, scope 2, and scope 3) are defined for greenhouse gas (GHG) accounting and reporting purposes.

Scope 1: Direct GHG emissions

Direct GHG emissions occur from sources that are owned or controlled by the College, for example, emissions from combustion in owned or controlled boilers, furnaces, vehicles, etc.; emissions from chemical production in owned or controlled process equipment.

Scope 2: Electricity indirect GHG emissions

Scope 2 accounts for GHG emissions from the generation of purchased electricity consumed by the College. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organizational boundary of the company. Scope 2 emissions physically occur at the facility where electricity is generated.

Scope 3: Other indirect GHG emissions

Scope 3 is an optional reporting category that allows for the treatment of all other indirect emissions. Scope 3 emissions are a consequence of the activities of the College, but occur from sources not

owned or controlled by the College. Some examples of scope 3 activities are extraction and production of purchased materials; transportation of purchased fuels; and use of products and services.

1990 Baseline total emissions: 32,513 eMTCO2

2009	
Scope 1 emissions:	27,341 eMTC02
Scope 2 emissions:	3,046 eMTC02
Scope 3 emissions:	2,623 eMTC02
Tree carbon sequestering offset:	(11,731) eMTC02
Net emissions:	21,279 eMTC02

2011	
Scope 1 emissions:	29,965 eMTC02
Scope 2 emissions:	2,699 eMTC02
Scope 3 emissions:	6,859 eMTC02
Tree carbon sequestering offset:	(24,771) eMTC02
Net emissions:	14,752 eMTC02

2014	
Scope 1 emissions:	26,579 eMTC02
Scope 2 emissions:	4,214 eMTC02
Scope 3 emissions:	6,736 eMTC02
Tree carbon sequestering offset:	(24,771) eMTC02
Net emissions:	12,758 eMTC02

GREEN HOUSE GAS ACTION PLAN

In the longer term, from 2016 and beyond, we see the solution for greenhouse gas emissions at the College as a two-pronged approach. First, the College must reduce demand on the central plant from building operations as much as possible. This will involve building envelope improvements, HVAC and lighting upgrades, building control upgrades, and change in operation and use of buildings, including significant plug load management. As time passes, new technology may present other alternative approaches. Second, the College, working together with staff and students, must consider implementation of different approaches in commuting to and from campus. To eliminate or reduce the 20% CO2 associated with transportation, integration of telecommuting, transportation and local shuttles will be needed, as well as other innovative ideas.

Reduction Strategy Descriptions

The College intends to use a variety of carbon emission reduction strategies as described below:

Renewable Energy

Generating power with a wind system typically involves a wind turbine mounted on a tower. The wind power available to a turbine at a given location depends on a number of variables, the simplest of which include wind speed, air density, and turbine swept area. If all of these variables are held constant, increasing only one of them will increase the power generated. However, these variables depend on a variety of more complicated factors unique to a site and the turbine considered. The "windiness" of a site is sometimes expressed in terms of its Wind Power Class. If one finds the

average power density at a site, one can identify its class. As all of the wind maps indicate that the College is not in a favorable wind class zone, no further analysis of wind was completed.

The Current Condition of Every Building

Every building on campus included in a consultant's analysis was reviewed for age, condition, and energy efficiency. Windows, wall and roof insulation identified on buildings with poor overall heat transfer coefficients (U values) were identified and the potential energy efficiency and related greenhouse gas impacts assessed. Newer buildings with insulated windows were not included as potential projects as the impact and cost are not normally viable. Minimum standards for building envelope upgrades and for new construction were recommended and developed with the campus architect and included as part of scheduled maintenance projects or prioritized based on greenhouse gas impacts differently. These recommendations include the replacement of single pane windows with R3, 1 insulated, Low-E glass, addition of insulation at non-insulated perimeter walls and roofs, and weatherization of doors and building seams.

Improvements in Lighting Technology

Current and future efforts to move away from lamps such as incandescent will provide the College with numerous opportunities over the life of the carbon action plan to modify its lighting. This will have to be balanced with the offsets that some technologies include, such as a lowering of electric consumption, but at an increase in mercury levels. To mitigate these competing issues the College needs to address the life cycle requirements of each new system and insure that issues related to recycling, disposal and hazardous materials are addressed during each opportunity evaluation. The consultant's lighting review identified that most areas on the campus have already been upgraded with compact fluorescent lighting (CFL) and more efficient T-8 fluorescents. However, opportunities to replace remaining incandescents, complete the replacement to CFLs, upgrade to LEDs where appropriate, and standardize the campus on lower wattage T-8 lamps offer significant potential for further reduction. Several of these can be low cost options as they can be executed based on changing the stocking criteria and ordering 25 watt T8 lamps to replace 32 watt T8 lamps and replace these as the older lamps fail.

LED technology has developed to be a viable, more cost effective option for lighting retrofits, which are currently underway. LED and LED based replacement systems are included in the periodic reviews to determine the correct time to begin the wide spread implementation of these technologies.

Heating Ventilation and Air Conditioning

The greatest challenge to achieve carbon neutrality on campus is to reduce the demand on the central plant as much as possible and to find an alternative power source to handle the balance of the load. A holistic approach to building renovations including building envelope, lighting, and HVAC together will have the most impact. Local building demand reductions will be most affected by integrating CO2 monitoring and determining where heating and ventilation loads can be reduced. VFD, full demand controlled ventilation systems, heat recovery (especially in areas with 100% outside air such as the Science Complex), and ground source geothermal heat pumps are all technologies that can significantly reduce demand. In addition, getting science areas to properly operate fume hoods is an issue. Automating this activity is something that requires further investigation along with analysis of CO2 monitoring (demand controlled ventilation) potential throughout the campus. The most significant impact of HVAC reductions on both the heating and cooling loads is the optimization at the central plant and cogeneration system. If electrical load reductions are implemented, additional

steam load will need to be achieved by burning natural gas or heating oil in boilers and thus will reduce the greenhouse gas reductions associated with reduced electrical load. By optimizing the HVAC loads with the electrical production the full greenhouse gas impact of both the electrical savings and the HVAC savings can be realized.

Retro-commissioning

Ensuring that all HVAC equipment and controls are operating at peak efficiency and per the facility requirements needs further analysis of individual building operations, but this can significantly reduce thermal and electrical loads. A campus-wide retro-commissioning program will ensure all equipment is tested with recommendations to return equipment to its optimal condition. The College has begun retro-commissioning in the Science Complex, which is energy intensive with 100% outside air exchange. Other buildings will follow on a prioritized basis based on energy intensity.

Equipment Replacement

Due to the nature of the tri-generation capacity of the central plant (electricity, steam, and chilled water), provision of chilled water for the campus cooling load where the majority of the cooling efficiencies can be realized presents an opportunity. Currently, a project is underway that replaces and old absorption chiller and cooling tower with a high efficiency electric centrifugal chiller with VFD pumping and a new, more efficient cooling tower.

Building Envelope Improvements

Additionally, building envelope improvements will have a direct impact on the individual HVAC building loads. However, equipment in a number of buildings including Brower Student Center, Decker Hall and the Roscoe West building have equipment that is older and could be due for replacement. Additionally, as all air handling equipment reaches its useful life expectancy, they will be replaced with the latest energy efficient equipment. Also, buildings that are currently using electric rooftop or window units will be evaluated for equipment replacement and connection to the chilled water distribution loop. These will substantially reduce the energy usage at the individual building and move the cooling load to the central plant where efficiencies will have the greatest impact.

Demand Controlled Ventilation

Using Carbon Dioxide (CO2) monitoring as a methodology for determining the required outside air for a conditioned area is used in areas where occupancy can vary significantly. For the College, this will be the academic buildings that are primarily classrooms or any large function spaces such as auditoriums or cafeterias. As most systems are designed for maximum occupancy, reducing ventilation air when spaces are unoccupied can provide significant energy and greenhouse gas savings. The College has this system in place in the Music Building. It is expected that rooftop air handling units with outside air intake on academic buildings will be candidates for this technology. Laboratory and kitchen hoods and their makeup air units are another opportunity for energy savings. The use of demand controlled ventilation and heat exchangers can improve the efficiency of these systems. Demand controlled ventilation can be installed on the hoods to adjust ventilation rates if permitted by local codes. These systems are significantly more expensive than the CO2 based systems due to the requirement of higher quality, contaminant specific sensors. Energy Recovery Units or heat exchangers can also be put in place and will be considered for the Science Complex.

Variable Refrigerant Flow

Variable Refrigerant flow systems will be considered for buildings that are being fully renovated (all ductwork being removed) and that also have a diverse building load that would include a requirement for simultaneous heating and cooling. These systems work by routing the hot (cold) refrigerant that is being returned from a cooling (heating) zone to a zone that requires heating (cooling). Use of these systems for a typical office building with a central core that requires cooling and a perimeter heating zone have shown savings of 15% when compared to traditional VAV applications. The administration and academic buildings are good candidates for this technology.

Central Utilities Plant and Cogeneration System Options

Chilled Water Systems

Currently the cooling/condenser water system is based on electric cooling towers. These towers consume significant electricity and the temperature of the condenser water will affect the operational efficiency of the chillers. As the condenser water temperature decreases, the energy required by the chiller decreases. With the use of a conventional cooling tower the system approaches a limiting factor determined by the outside air temperature. During the summer this is at or near the design point of the chiller and these units reach maximum energy consumption. Free cooling, which utilizes a plate and frame heat exchanger, is currently being installed for the shoulder months to reduce use of the cooling towers.

Another consideration regarding the central plant chilled water system is determining the optimal scheduling of the equipment. Currently, the procedure is to always run a thermally based chiller. When the plant is producing steam as a recovered by-product of the cogeneration system (free steam) the use of the thermal chillers is the most cost effective method of producing chilled water. However, once the chilled water demand reaches the point where the operator has to dispatch the backup boilers to generate additional steam, the economics of the process change. Traditionally what is done in this case is to calculate the cost of producing the next ton-hour of chilled water. This will be a moving target as changing from steam to electric has impacts on the cogeneration system and will change the dynamics of steam production in the HRSG. This is also compounded by the difference in price between cogenerated electricity and purchased electricity, and the fluctuations in the pricing of natural gas, fuel oil or purchased electricity. Additionally, dispatching of equipment takes into account the impact on greenhouse gas, as the emissions from duct firing and stand-alone boilers are different than the emission profile of electric generation.

A project is underway to expand the chiller plant for the increased cooling loads for the new STEM building, a Chemistry addition and an addition to Brower Student Center. Advanced metering and measurement devices are planned to optimize the efficiency of the chiller plant.

Cogeneration Plant

One auxiliary system that should be evaluated for upgrade or replacement is the natural gas compressors. These units are currently reciprocating compressors and have a history of maintenance issues and associated costs. These units can be upgraded to state of the art units and will perform the required function while using less electricity. This will reduce the plant's parasitic load and will provide additional power to the remainder of the campus for the same fuel input. While the direct measurement of this upgrade is not quantified it will be measurable as a reduction in purchased power.

An analysis should be completed on the long term value of changing the cogeneration gas turbine. As this reaches the end of its rated life it may be in the best interest of the College to install a newer, more fuel efficient model and the size. This would allow the College to optimize fuel performance with electrical generation. This recommendation can be completed in stages and will be addressed as these units begin to reach the end of their rated operational life.

One major, long term, option relating to the reduction of greenhouse gas emissions is the use of an alternative fuel source in the turbine. The existing turbine is currently designed to operate on both natural gas and liquid fuel (FO#2). As the College moves to a reduced carbon footprint and a more sustainable campus, one option is the use of a bio-fuel in place of the two current fuels. The biodiesel or a similar bio-liquid fuel would be a more sustainable fuel than natural gas or FO#2 and as a renewable fuel has a greenhouse gas coefficient much lower than both natural gas and petroleum based diesel fuel. The use of bio-fuel allows for an upfront investment of $3.4 million in equipment but a significant operation cost in fuel of $9 million annually, making this option less desirable long term. This additional operational cost will have to be considered in the entire carbon neutrality plan.

It is recommended that the next units converted under this scenario would be the backup boilers as they are currently configured for both natural gas and FO#2 operations. Again, the only change would be operational costs as the units are configured to operate on liquid fuel. The anticipated capital cost would be minimal and the operational cost would be identical to the cost listed above. The next unit to be converted would be the combustion turbine. As stated earlier the only change would be the operational cost difference. In this option the pricing difference is based on the incremental cost increase of biodiesel over natural gas. This will be monitored and the decision to execute the switch will be tied to these considerations.

The final candidate for a fuel switch is the duct burner that fires the heat recovery steam generator (HRSG). The heat recovery steam HRSG produces steam as a by-product of electricity production from the hot exhaust from the gas turbine. During certain periods, the thermal demand is greater than the steam generated by the college's electrical demand. At this point, natural gas is combusted in both the turbine and duct burner, with the heat diverted into the HRSG to produce additional high quality steam which can be used by the system. This is one area that would have a capital requirement as the current duct burner is natural gas only and the burners, fuel delivery system, flame safety system, and controls would have to be modified to use a liquid fuel. This option would have the same operational considerations as the combustion turbine switch as the base fuel price will be natural gas.

Plug Loads

As the growth of computers, electronics, appliances and other devices have flooded the work place and the educational market, plug loads have begun playing a larger role in energy use within buildings. The old paradigm for electric consumption in a building was 40% lighting, 40% HVAC, and remaining divided among plug loads. With improvements in lighting and HVAC the percentage for these has decreased to the point where recent studies by the Department of Energy show that upwards of 50% of building loads may be plug loads. These are divided between active and passive usage. Tramp or passive load requires finding a method to truly turn off equipment when not in use. This is most notable in constant power draws from transformers imbedded in equipment such as copiers, fax machines, computers, cell phone chargers, space heaters, etc. These can now be controlled with items such as occupancy sensor based power strips to cut off the power during periods of non-use. This lost or neglected load is becoming an important part of reducing overall demand on the central plant. It is estimated that adding sensor power strips and improving occupant habits will save an estimated

280,000 kWh in energy use annually. The cost for this is nominal and would have little to no impact on productivity.

A purchase policy for purchasing only Energy Star labeled products has been implemented at the College and will significantly reduce electric consumption at a minimal increase (if any) in purchasing costs. Educating the campus energy users regarding energy efficiency techniques including turning computers and lighting off, and reducing air conditioning or heating use can be implemented and can have significant impact on plug loads.

Travel and Tree Carbon Sequestering Analysis

Transportation has proven to be the second largest contributor to the campus greenhouse gas footprint. There currently exists a substantial amount of surface parking. In addition, large parking structures further encourage the use of cars to and from the campus. The campus exists on a major highway, Rt. 31, and within 15 minutes of two major train stations, Hamilton and Trenton. Currently, there is no campus provided shuttle between these stations that or a shuttle from campus to nearby necessities such as grocery, retail, bank, or medical facilities. In order to reduce student and staff transportation, we believe three very large shifts in the way the campus operates must be considered. The first is to consider implementing distance learning and telecommuting technology extensively so that students, faculty, and staff are not required to commute to campus daily. The second is to consider providing shuttles to trains and local services and encourage their use by initiating a carbon penalty payment for parking. Third, actually restricting the number of cars allowed on campus is something that should be able to happen naturally over time as telecommuting and public transit increase, but is a necessity.

Related to this, the College must replace their fleet with carbon neutral vehicles, or at least hybrid vehicles that use 50% less fuel. It is also likely in the next ten years that the auto industry will assist by making alternate fuel cars more widely available. TCNJ will follow this trend closely and be prepared to install alternative fuel stations. Recently, the College installed 5 electric car charging stations as a pilot project.

<u>Leadership in Energy and Environmental Design</u>
Buildings were analyzed for LEED Existing Buildings Operation and Maintenance with a goal of LEED Silver for all existing and new construction. LEED EB analysis shows that most buildings have the potential to meet silver certification or better, assuming correct policies and operational procedures can be put in place and Energy Star can be met. A detailed impact analysis of each building is needed if the College elects to pursue LEED EBOM certification for any particular building. Every building has the potential of achieving LEED EBOM Silver certification but a substantial campus-wide change in cleaning, purchasing, and operating policies are needed to make this happen. Existing buildings are often more difficult to get certified as well because they are required to meet an Energy Star rating of at least 69. The older buildings on campus will be unable to do this without significant investment in building envelope, HVAC, lighting, and controls.

New construction, however, is relatively easy to meet the requirements of LEED NC at little or no additional cost. Selection of an experienced green building design team, use of integrated design practices, and identification of available incentives and grants are all key to insuring cost effective implementation of LEED principles in new construction. Knowing that one of the main goals for

the College is carbon neutrality, requiring design teams to achieve all points under Energy and Atmosphere Credit 1 would be a logical requirement for new construction. That will result in new buildings which are 40% better than code. LEED is also much more holistic than just energy use. Credits for connection to public transportation, provision of preferred parking for high efficiency vehicles, connectivity to local community services, reduction in potable water use, specification of materials harvested within 500 miles, and use of demand controlled ventilation are just some of the many holistic approaches and credits in LEED that contribute directly to reducing greenhouse gas emissions. In general, there is a correlation between many LEED credits and carbon neutrality.

CURRENT INITIATIVES AND PLANS FOR ENERGY USAGE AND FACILITIES

Most of The College's GHG emissions come from energy generation and usage, including providing top-quality physical facilities for the academic environment, co-curricular programming and student residences. While greener technologies pay off on the long term, the initial cost of such investments can be considerable. TCNJ has made such commitments, as described below.

The College has reduced or eliminated greenhouse gas emissions through the following programs and strategies:

- The College has constructed only LEED Silver new buildings since 2005. These include new residence halls, new Art and Interactive Multimedia Building, a new Library, a new School of Education, and a mixed use development called Campus Town. The College is in the process of construction of a LEED Silver Chemistry building and a new STEM building.
- The College has an energy efficient co-generation plant.
- Based on an analysis by Sightlines, a national operations benchmarking firm, TCNJ's co-generation plant is more efficient than the average institution and many of our peers;
- TCNJ's waste is sorted and inventoried by each area that generates waste. Arrangements are then made through TCNJ's Facilities department for these generated wastes to be properly prepared and manifested for transport, and ultimately disposed of off-site by an approved hazardous waste contractor.
- The Office of Building Services has completed the transition of cleaning chemicals over to Green Seal Certified, which will bring the College up to 90% of the chemicals being Green Seal Certified.
- The College operates a co-generation plant utilizing natural gas as the primary fuel to provide steam, chilled water and electricity to the campus.
- The College utilizes shallow well geo-thermal systems to heat and cool academic and residential facilities across campus.
- The College undertook a campus tree inventory program using students and faculty to measure the sequestered carbon found in the campus trees.
- The institution has committed to designing all of its facilities to a minimum of LEED (Leadership in Energy and Environmental Design) Silver level. The new Education and Arts buildings meet these standards.
- The institution has committed to the purchase of only Energy Star equipment and appliances where they exist in the marketplace.
- The College has changed lighting from metal halide to compact fluorescent in parking structures.
- The College has installed occupancy sensors in buildings including all common rooms, and conference rooms.
- The College undertook building envelope upgrades.
- The College underwent a campus lighting upgrade in which all practical interior lighting in buildings changed to compact fluorescent.
- The College converted street lamps to compact fluorescent in 100% of all outdoor lighting fixtures.
- The institution has established a program supporting carbon sequestration in trees. Utilizing a United States Environmental Protection Agency (USEPA) metric for the 2014 greenhouse

gas (GHG) inventory, we estimate that our wooded properties equate to savings of 24,771 eMTCO2 and our total net emissions for 2014 are 12,758 eMTCO2. This is 20,000 eMTCO2 reduction in our GHG trajectory stated in our Climate Action Plan.

- The institution has embarked on a comprehensive HVAC system upgrade program which will save energy. This is being completed through a planned effort in the institution's Asset Renewal Program.
- The College began an equipment replacement initiative to save energy which is part of the College's Asset Renewal Program.
- TCNJ began a Demand Controlled Ventilation initiative that will save energy. This will be implemented through the Asset Renewal Program as resources allow.
- TCNJ created a Variable Refrigerant Flow program that saves energy. This will be addressed through the Asset Renewal Program as resources allow.
- The College is completing chilled water plant upgrade that will be a major energy saver. This is being done as part of an Engineering Master Plan in conjunction with the new STEM building and Science Complex Renovation.
- The College is investigating in energy efficiency upgrades to the College's co-generation plant. These are being evaluated as part of the Engineering Master Plan;
- The College has installed and uses solar photovoltaic cells to power lights in the Maintenance Building.
- The College has installed natural gas cooling and heating distributed generation plants for Phelps and Hausdoerffer residence halls, for which the College was granted $110,400 through the New Jersey Smart Start Program.
- The College has established Minimum Energy Performance criteria whereby all new construction projects are designed to comply with ASHRAE/IESNA 90.1-2010, in accordance with LEED.
- The College has established an Optimize Energy Performance goal whereby all renovation projects aim for a 20% - 25% energy reduction.
- The College has adopted On-Site Renewable Energy whereby various renewable energy sources are considered, depending on the project and the site. Geo-thermal wells were used at Loser Hall and the Townhouses. Fuel cells were installed to supply the electrical grid and to use the waste heat for domestic water at the Student Apartments. Solar panels supply electricity in the Facilities building.

The current construction of the Chemistry and STEM buildings meet LEED Silver qualifications, demonstrating a significant financial investment by The College in GHG reduction. Additionally, these features will decrease future energy and maintenance costs.

The College is in the process of re-energizing the Knowledge is Power (KIP) energy conservation initiative that was developed several years ago. KIP focuses on simple, but effective, energy conserving behavior. Among them, keeping the heat set at 68 degrees in the winter and 78 in the summer. This program will raise awareness of energy conservation, plug load management, temperature control and dressing for comfort, strategies designed to save energy and reduce TCNJ's greenhouse gas footprint. For more information see: http://energy.pages.tcnj.edu/initiatives/energy-policies/

Additional infrastructure investments include the construction of a high efficiency plant chiller (slated to be complete in late 2017) and the energy efficiency focus of the Asset Renewal Plan

CURRENT INITIATIVES AND PLANS FOR TRANSPORTATION

Given TCNJ's suburban campus and its relative distance from densely populated developments, developing a comprehensive transportation plan to reduce greenhouse gas emissions associated with commuting and transportation has presented difficulties. Of the total GHG emissions from The College, 20 percent come from commuting. Efforts are being made to address these issues through the study and promotion of alternative means of getting to and from campus.

The College is has implemented a variety of programs to promote the use of alternative transportation including:

- Providing on its website information about alternative means of transportation to the College. This includes bus schedules from local train stations to campus, information on bike routes and the availability of showers for those who do bike to campus.
- The College, in collaboration with our housing development partner, has brought a car sharing service to campus run by Enterprise Rent a Car company. This service gives those on campus who need transportation access to a fuel efficient car for short durations and at low cost.
- The College engaged a consultant to create a Multi-modal Transportation Study and Plan for the institution. The plan has outlined dozens of projects to improve all forms of transportation to and from campus and the College is implementing select projects from this plan.
- The College actively promotes the use of bicycles on campus. Buildings have bike racks and many residence halls have bike storage rooms. The College has invested in bicycle racks increasing the capacity by 80% in the past several years.
- The College is linking its pedestrian and bicycle pathways to the Lawrence Hopewell Trail and other bikeways throughout Mercer County to create a seamless network of bike routes to and from the campus.
- The College sponsors and operates a shuttle bus called the Loop Bus that provides alternative transportation for students to local places of interest including malls and commercial centers.
- The College recently relocated and expanded its NJ Transit bus station to the mixed use Campus Town development which makes it more accessible, convenient and visible for the community to use.
- The College has recently purchased six cargo vans that were assigned to the Office of Facilities Operations, which are Flex-Fuel vehicles;
- The College has constructed and opened a residential and commercial mixed-use complex called Campus Town. This complex, unlike many other living environments on and around campus, does not require a car to be able to live independently. Residents of Campus Town have many of the service, food and entertainment amenities that they need at their doorstep.

TCNJ RIDESHARE APP

PC3 is working on several current and future initiatives to reduce GHG emissions from commuting. Most notably, PC3 teamed with the Computer Science department to develop "TCNJ Rideshare," a smartphone application that allows students to share rides for daily commutes or occasional trips. TCNJ students developed this app to fit The College's specific needs. Previously, TCNJ used a web-based platform to encourage carpooling. This program was a bit cumbersome to use and had more functions and options than what was needed. Because of these difficulties, usage was limited. The TCNJ student developers created an app that had just the functions needed in order to keep the

product simple and easy to use. Users create a profile that includes only their name, email address, and type of car they drive (if they have one). Next, they request or offer a ride by entering the starting point and destination of their ride (specific addresses are not required). The program then notifies users when a match is made, and users can chat with one another to see if they are compatible and figure out the specifics of the ride. All information is secure.

Only members of the TCNJ community can access this service. Creating a profile requires a TCNJ email address, which the app uses to verify that the person is a TCNJ student, staff member, or professor. TCNJ Rideshare calculates the emissions saved for each trip and reports the sum to the administration. The College keeps track of emissions saved through TCNJ Rideshare and other energy efficiency initiatives. TCNJ Rideshare contribute to The College's leadership on addressing climate change.

The most frequent users of TCNJ Rideshare will earn exclusive rights to a premium parking spot for a month. Premium parking spots are available in the front of lots 1 and 4 (for faculty and staff) and lots 5 and 7 (for students). The most frequent users of TCNJ Rideshare receive a hangtag that allows them, and nobody else, to park in the spot for a month.

The publicity campaign for "TCNJ Rideshare" began in the spring 2016 semester. PC3 has dedicated substantial effort to inform students, address large student groups, and attract media attention.

ELECTRIC CAR CHARGING STATIONS

In partnership with the local utility, PSE&G, the College is installing electric car charging stations which will be free to use by College faculty and staff who register their electric cars. This program increases the viability and visibility of commuting via electric vehicles to campus.

"TCNJ BIKES"

PC3 and the Bonner Scholars will continue "TCNJ Bikes!" In an effort to reduce the college's commuting carbon footprint, Bonners are involved in a bike-to-campus campaign to encourage students, faculty, and staff to bike to, from, and around campus. This involves providing information about how to bike safely, where to park and repair bikes, and promotional giveaways of biking gear.

When asked what the top three actions could be taken to encourage biking on campus, respondents reported, in descending order, that a) weather-protected bike parking on campus, b) safer routes to campus, and c) secure bike storage on campus would increase biking at TCNJ. Safer/clearly marked routes to and from TCNJ, and convenient places to shower after biking were also provided as incentives to bike more frequently to campus. Taking into account the survey results, the next steps to be taken to improve the frequency and safety of biking in and around TCNJ include two critical issues: improving the quality and quantity of bike racks on campus, and improving / expanding / mapping the current infrastructure for bikers at TCNJ. Existing bike racks do not provide an efficient use of the space where they are placed, due mostly to the inability of access to both sides of the rack (e.g. shrubs or lack of paving blocking one side of a bike rack). TCNJ bike racks also do not provide adequate cover from inclement weather and do not offer enough security to allow bikers to feel safe enough to keep their bikes on campus.

TCNJ's two formal entrances are via Pennington Road and Green Lane. Neither entrance offers safe or convenient access for bikers. Metzger Drive continues to be incompletely connected with

sidewalks, posing a threat not only to bikers, but also to joggers and pedestrians forced to either walk on the grass, or on the street towards oncoming traffic. In order to meet these concerns, the two main entrances could be modified to allow bikers' access to TCNJ, or separate biking/pedestrian paths could be laid out in order to ensure safe transit for non-automotive transportation. Lastly, off-campus bikers are deterred from biking due to the stigma of biking to campus on unmarked major roads. Information dissemination concerning alternative biking routes in Ewing Township to TCNJ, as well as marked bike paths created around off-campus student residents, is underway and will hopefully generate greater rates of biking to, from, and on campus.

PC3 has been looking into addressing these issues as well as the installation of bike repair stations to encourage more students, staff, and faculty to bike to campus. PC3 hopes to install at least three such stations on campus but currently lacks the funding to do so.

PEDESTRIAN ACCESS

PC3 has been monitoring recent campus improvements in order to improve the ease of walking to campus. Infrastructure connecting the surrounding neighborhoods with campus represent a significant limitation on encouraging walking to and from campus. Only three paved pedestrian access points exist (Lynwood Drive [pedestrian and bikes only]; Pennington Road entrance; Green Lane entrance) and entrances are designed with automobile movement as a priority.

DISTANCE LEARNING

Additionally, The College encourages implementing distance learning and telecommuting technology extensively so that students, faculty, and staff are not required to commute to campus daily. Distance learning has been made available for some courses, although the nature of a liberal arts college suggests this can and should only have limited applicability.

PLANS FOR REDUCTION OF CONSUMPTION, TRASH AND WATER USAGE.

While often not accounted for in formal carbon metrics, the consumption of food, water and consumer goods implies significant GHG emissions. The production, packaging, transportation, and disposal of such items requires energy and raw materials. The College is committed to reducing wasteful consumption, and hence reducing GHG emissions, wherever possible. Some reductions come from changing the production or purchasing processes. Other reductions rely on education campaigns to change habits of students, staff, and faculty. Past initiatives include:

- Continuation and expansion of campus-wide recycling containers;
- Implementation of a single stream recycling effort and education program/recycling website;
- Use of recycled paper in towel dispensers;
- Installation of scrap dumpster for metal scrap collection;
- Implementation of a program to recycle yard waste at no cost;
- Developed recycling educational programs including Welcome Week bags containing recycling flyers in student residence rooms; "TCNJ Recycles" as part of Welcome Week, and all Residential Education staff receiving website training for TCNJ's recycling program;
- Held "America Recycles Day" activities regularly in dormitory buildings including trivia games about recycling;
- Continuation of a "Dump and Run" program whereby students donate unwanted appliances, household and clothing items to local charities in lieu of putting them in the trash;
- TCNJ is recycling our residential mattresses instead of throwing them into the solid waste stream;
- All green material from campus is sent to a composting facility versus including it in the trash stream (represents an estimate of 40 dump truck loads);
- Using drought-resistant grass, shrubs and trees to reduce watering requirements;
- Using indigenous planting materials that do not require special treatments to thrive in the environment;
- During the months when the co-generation plant's inlet cooling coil is operational, Grounds uses the water that condenses from the warm, humid air to help water plantings that don't receive enough rain water;
- Designed the southwest quadrant of the campus to increase pervious surfaces by one acre resulting in an increase in ground water surcharging;
- Implemented a comprehensive storm water management plan which includes labeling of all storm drains, educational programs and storm water retention structures across campus;
- Established a wetlands conservation easement around the College's lakes and streams allowing them to return to their natural state;
- Planning for the removal of an old dam structure to restore a stream corridor to its natural condition.

Currently, The College is installing hydration stations to reduce the usage of water in recyclable plastic bottles. The new installation in Eickhoff Hall on February 12, 2016 saved over 235 bottles water from filling our landfills in just its first week of operation. The campus community is encouraged to actively participate in this initiative with Hydration Stations located in Eickhoff Hall, Norsworthy, and more to come in convenient locations such as the Brower Student Center.

The College will continue its various recycling program, including "America Recycles Day," "Dump and Run" and the daily collection of significant amount of recyclable materials. Plate scrapes and other awareness campaigns will continue.

A composting program has been under consideration for three years yet the cost remains prohibitive. PC3 will continue to monitor the local market for refuse services to see if the composting of food waste would be viable.

PLANS FOR EDUCATION, RESEARCH, AND PUBLIC ENGAGEMENT

The College has demonstrated a commitment to sustainability and climate neutrality in areas related to education, research and public engagement. Five academic programs directly or indirectly address climate change and related impacts: the Environmental Studies Concentration, the Environmental Studies minor, the Environmental Sustainability Education Minor, the Public Policy minor, and Technological Studies. Additionally, TCNJ faculty offer across several disciplines classes on aspects of climate change or related issues and conduct research on climate change. TCNJ's public engagement consists of the work by the Sustainable Institute, the activities of several student clubs and awards that The College has won based on its efforts in environmental policy.

The College offers five academic programs focused on the environment. All four allow students to pursue issues of climate change specifically. A liberal learning (or general education) option entitled "Environmental Studies Concentration" includes courses from the Sciences, Arts, and Humanities and Social Science, along with a required senior capstone project. All of the courses, although diverse in their perspective, revolve around current issues in environmental studies (e.g. sustainability). Specific information can be found at:

http://liberallearning.tcnj.edu/courses-information/interdisciplinary-concentrations/environmental-studies/

Approved by the Board of Trustees in fall 2015, the Environmental Studies Minor preserves the importance of studying the environment from multiple disciplinary perspectives, but narrows its focus of courses to those with content and learning goals explicitly centered on the human/environment relationship. The minor deliberately embraces multi-disciplinarity, and at the same time reinforces a growing community at TCNJ that seeks and values interdisciplinary inquiry. As such, the minor has incorporated an additional school (Engineering) and is being developed in conjunction with the minor in Environmental Sustainability Education (SE) in the School of Education. Before the minor was approved, associated students and faculty members wrote and publicized the "Hurricane Sandy Project" and more climate-related research is expected from this recently-launched program. For more information, see:

http://environmentalstudies.tcnj.edu/about-environmental-studies-minor/

Started in spring 2015, the Environmental Sustainability Education Minor is an interdisciplinary 5-course minor designed to develop content knowledge and teaching skills to give TCNJ students the tools to teach sustainability professionally. The minor is housed in the School of Education but open all TCNJ students. Minor participants are organizing Earth Week activities for April 2016. The first iteration environmental sustainably education research are beginning to be disseminated:

- Student researcher Jennifer Liang presented findings at the CTUAN conference at the UN this past December (http://www.tcnjsignal.net/2016/02/02/student-presents-poster-at-un-conference/).
- These findings will also be presented at the American Educational Research Association and National Association for Research in Science Teaching conferences this spring. An article is under review at *Environmental Education Research*.

- A student who took several courses in the program and graduated last spring, Courtney McGovern, published her independent study work with me in *Green Teacher Magazine* (http://greenteacher.com/from-stems-to-stem/).
- A paper presenting eco-literacy development that two professors and college students co-authored has been accepted at the *Journal of College Science Teaching*.
- More information can be found at https://envsus.pages.tcnj.edu/

The Public Policy minor aims to increase students' understanding and active participation in efforts of the public sector to address a wide range of social problems. While many human interactions can be accomplished best through private interactions, some of the most important issues in society fall under the public sphere due to their direct or side effects on third parties or the mass public. Students can specialize in environmental policy. For example, while she is studying in New Zealand in spring 2016, TCNJ undergraduate Elsa Leistikow is using her TCNJ coursework to intern with a Member of Parliament from the NZ Green Party and develop a platform on green urban development platform for the 2017 general election. More information is at http://polisci.tcnj.edu/academic-programs/

The Technological Studies program prepares P-12 teachers to deliver the New Jersey Technology Education Standard (Standard 8.2), which requires significant exposure to sustainability and green technology. Students from the School participate in a solar-powered boat project every year. More information can be found at http://technologicalstudies.tcnj.edu/

The Cultural and Intellectual Community Program Council (CICPC) chose "College and Change" as the intellectual theme for the 2015-16 academic year. Issues of sustainability were interwoven into programming targeted at first-year students. The summer reading assignment form freshman was James J. Farrell's The Nature of College. The book asks what students can learn in college to help them become responsible agents of change in society and in society's relationship to the nature world. This work set the tone for further assignments and culminated in an on-campus presentation by environmentalist David Orr.

The College offers an extensive catalogue of environmental and sustainability courses in its many schools and units. These courses are offered each semester or annually and include the following:

First-year Seminar: FSP 164: The Politics of Climate Change

School of Business: ECO 350: Economics of Environmental Quality

School of Education: MST 203: Environmental Science for Educators

School of Engineering: CIV 381: Introduction to Environmental Engineering

School of Humanities and Social Sciences
ANT 341: Environmental Anthropology
ANT 345: The Politics of Climate Change
HIS 188: Environmental History
JPW 270: Reporting on Health and Environment
LIT 318: The History of Nature
POL 355: Political Economy of Natural Resources

POL 370: Global Environmental Politics
PHL 265: Environmental Ethics
SOC 345: Inequality, Pollution, and the Environment
ETE 470: Environmental/Biotech Systems
WGS 374: Ecofeminism

School of Science

BIO 173: Humanity and the Natural World
BIO 221: Ecology and Field Biology
BIO 315: Plants and People
BIO 360: Oceanography
BIO 365/366: Natural History of the Galapagos Islands
BIO 375: Environmental Quality, Protection and Health
CHEM 365: Chemical Aspects of the Environment
PHY 120: Introduction to Geology
PHY 171: Introduction to Meteorology
PHY 220: Advanced Geology
PHY 345: Physics of Clouds and Climate

Several faculty incorporate climate change in their general curriculum courses, including:

- Professor Matthew Cathel - Biotech Environmental Systems course;
- Professor Susanna Monseau - environmental law and legal responses to climate change;
- Professor Don Hirsh - laboratory on carbon dioxide monitoring;
- Professor Leeann Thornton – the carbon cycle and the role of plants in global warming;
- Professor Karen Becker - consumer attitudes toward climate change;
- Professor Diane Bates - climate change and probability models;
- Professor Janet Gray - climate change in children's literature;
- Professor Janet Morrison – the effect of global warming on tree/pest dynamics in Western forests;

Selected TCNJ faculty research and teaching on sustainability includes:

1. Dr. Matthew Cathell is creating innovative school activities to help teachers understand remediation of contaminates, presented a talk for teachers on "The Environment and Society" for the TCNJ Technological Studies Department professional conference in the Fall of 2008, and will be participating in the National Teach-in on Global Warming.
2. Dr. Lisa Grega, with two students, is working on a project funded by the New Jersey Board of Public Utilities to identify sites for wind turbine deployment in the central New Jersey area.
3. Dr. George Facas is working with students to create a semi-portable water desalination/ water purification device to provide sustainable potable water to communities with limited fresh water.
4. Dr. Steve O'Brien is working with students on a solar- driven Stirling engine (thermal power converted to mechanical power), a river-powered generator, and a mobile power source for laptops.
5. Dr. John McCarty has published on marketing and environmental issues, specifically how to use marketing to get people to engage in environmentally responsible behavior.

6. Professor Margaret Benoit working with TCNJ undergraduates, is developing quantitative methods that apply to near-surface environmental problems such as groundwater contamination.
7. Professor Nathan Magee with his students has worked on ice crystal kinetics with direct application to cirrus clouds and their influence on climate.

The Bonner Institute for Civic and Community Engagement is responsible for mobilizing faculty, students and staff to help sustain and advance the communities in which we live; in other words, to find mission-consistent ways to improve the quality of life for all. The Institute works with partners throughout the Trenton community as well as Mercer, Burlington, and Hunterdon Counties to address many issues including poverty, homelessness, hunger, education, environmental needs, juvenile justice, health, immigration and more. The Institute accomplishes all of this through the Bonner Community Scholars Corps, a group of over 100 TCNJ students who receive academic scholarship to provide meaningful service to the community and mobilize the campus as part of the Community Engaged Learning program. Within that group, 16 Bonner Community Scholars are part of the Environment Division, which focuses specifically on environmental issues in the region, including on campus. In addition to what has been described above, other Bonner initiatives include:

- Bike-to-campus: In an effort to reduce the college's commuting carbon footprint, Bonners are involved in a bike-to-campus campaign to encourage students, faculty, and staff to bike to, from, and around campus.
- Food waste: Working with TCNJ Dining Services and Facilities and Grounds, Bonners have spearheaded efforts to redirect food waste from the landfill stream to an off-site compost facility.
- Educational campaigns: Bonners regularly conduct tabling and interactive informational activities regarding electricity and water conservation, recycling, food waste, and end-of-year residence hall goods recycling.
- Campus garden: Started in 2009, TCNJ's campus garden is a partnership among PC3, Bonners, the TCNJ Biology department, TCNJ Facilities and Grounds, and community partners. Serving as a site for environmental and food education, the garden most recently produced nearly 900lb of organic food, donated to Mercer Street Friends' Food Bank.
- Reduce for Good Use: At the end of the spring semester when students move out, Bonners conduct a donation campaign, collecting reusable items from students' rooms to donate to Rescue Mission, a regional social services organization.
- Film screenings: Bonners regularly host film screenings on environmental issues, including Disruption on climate change activism, Bag It on the effects of single-use plastic bags.
- Transit and Transportation initiatives: Bonners and Bonner Institute staff conducted a campus-wide survey on transit and mobility patterns of the campus community to better understand mobility demands and areas for sustainability improvement. These results will be used to pursue transit and mobility improvements, including: shuttles between campus and transit centers, improved bus service, shuttles between campus and student-populated neighborhoods, improved bike and pedestrian amenities, and general parking and transportation adjustments.

The division between curricular initiatives (above) and public engagement (below) is often blurred. For example, many Bonner initiatives or faculty presentations of research are attended by the general

public. Other contributors to TCNJ's public engagement on climate issues include the Sustainable Institute, student clubs and awards received by members of The College.

The Sustainability Institute at the College of New Jersey is a "think and do" tank that administers a number of cutting edge research and outreach programs focused on sustainable development, including the award winning "Sustainable Jersey" municipal certification program; Sustainable Jersey for Schools; the New Jersey Resiliency Network; the "Regional Hubs" program, and numerous federal and state grant-funded projects. The Sustainability Institute's mission is to advance sustainable development through research, outreach, and training. The Institute works with local, state, and federal government, as well as the private sector, to help decision makers develop better capacity to understand the long term consequences of their actions, and develop and deploy best practices in a number of policy areas.

The Sustainability Institute has significant programs and capacity (including research, policy and program design, and program implementation) on a number of issues, including urban planning, land use and transportation, energy, green infrastructure, decision making processes, the use of indicators in decision making, building leadership, climate adaptation policy and planning, and economic development. The Sustainability Institute@TCNJ is engaged in important green research, teaching and outreach initiatives that balance economic development with environmental protection and natural resource conservation, including:

- The award winning municipal "Sustainable Jersey" program. Sustainable Jersey is a multifaceted program designed to aid municipalities in achieving their sustainability goals. The program develops new models and best practices, conducts outreach, and provides technical support, grants, and other incentives to support municipal progress. Over 422 municipalities participate in the municipal Sustainable Jersey program and collectively have implemented over 4,000 discrete best practices as part of the program. One hundred seventy-seven municipalities have been certified to date; 149 at the "bronze" level and 28 at the "silver level. Sustainable Jersey includes 22 task forces whose membership consists of approximately 150 New Jersey leaders, experts, and organizations including government agencies, non-profit organizations and businesses.
- The NJ Resiliency Network, is a new strategic initiative of the Sustainability Institute that helps communities access technical and financial resources to address long-term recovery and resiliency issues for post-Sandy municipalities in New Jersey.
- Sustainable Jersey for Schools is a voluntary sustainability certification program designed specifically for New Jersey's public school districts and public charter schools. Similar to the municipal program, Sustainable Jersey for Schools convened experts, local school officials, educators and other stakeholders to determine the content of the program. In July, 2013 over 100 people attended a kick-off meeting at The College of New Jersey where working groups, representing the various partners, began to define the program standards and actions that would advance schools toward certification. Twenty-eight districts and 58 schools are currently registered with the program.
- In 2014, the Sustainability Institute launched its "regional hubs" program with five hub "pilots" in:
  - Atlantic-Cape May
  - Camden-Burlington and Gloucester called the "Regional/Urban Partnership for Sustainability"

- Essex
- Mercer and
- Somerset.

In addition to coordinating quarterly events, the hub members have been mentoring budding green teams, which in several cases resulted in new municipal participation in the Sustainable Jersey program. Moving into their second year, the hubs will be focusing on setting up a leadership structure to help make them more self-reliant and sustainable. In 2015, additional hubs will be getting underway in Hunterdon, Monmouth and Middlesex Counties.

Two TCNJ student clubs directly address environmental issues. First, the TCNJ Environmental Club (formerly Water Watch) hosts cleanups of the college as well as other areas throughout the state, including some of the beautiful beaches at the Jersey Shore. During these cleanups, college volunteers unite to help the environment. The Club gives recycling presentations to many of the different organizations on campus, teaching other clubs the 'hows' and 'whys' of recycling. In addition, the club teaches a week's worth of lessons to TCNJ's Career and Community Studies students about the importance of the keeping our environment clean. During stream-walking, Club members take samples from both lakes on campus, and streams in Ewing Township. The goal is to benefit the township by providing analysis of the water quality through biological and visual assessments. Currently, the Club is planning events for Earth Day. For more information see http://tcnjwaterwatch.weebly.com/

A second club, Engineers Without Borders - USA (EWB-USA), is a non-profit humanitarian organization established to partner with developing communities worldwide in order to improve their quality of life. This partnership involves the implementation of sustainable engineering projects, while involving and training internationally responsible engineers and engineering students. TCNJ engineering students, accompanied by Dr. Michael Horst, travel to Southeast Asia to work on sustainable projects, including delivery of potable water using solar powered pumps.

Finally, TCNJ has received numerous awards for its facilities, health and environmental programs including the following:

- PlanSmart New Jersey, Resource Efficiency Award for Campus Town, 2015;
- New Jersey Alliance For Action, NJ Leading Infrastructure Project Award for Campus Town, 2014;
- Princeton Review, Guide to Greenest Colleges, annually named in this guide created in partnership with the Center for Green Schools at the US Green Building Council;
- United States Environmental Protection Agency, Combined Heat and Power Partnership Founding Partner, ongoing;
- NJBiz Green Leadership Awards, Alternative Energy Use Award, 2009;
- United States Environmental Protection Agency, Energy Star Award for Combined Heat and Power (CHP), awarded to TCNJ for its cogeneration plant, 2001;

The College has demonstrated a commitment to sustainability and climate neutrality in areas related to education, research and public engagement.

CONCLUSION

Since signing the ACUPCC pledge, the College has accomplished significant reductions in net GHG emissions. While the size and power demand of TCNJ has grown, efficiency gains and carbon offsets have led to consistently lower net emissions.

Table one describes GHG reduction initiatives recently launched or planned in the next three years, including emissions category, actors and resources, and status as of February 2016.

Table 1-Greenhouse Gas Reduction Initiatives

Initiative	Emissions Category	Actor and Resources	Status
LEED Silver Status for STEM building	Energy and Facilities	Lynda Rothermel, Campus Architect	Under construction.
LEED Silver Status for Chemistry building	Energy and Facilities	Lynda Rothermel, Campus Architect	Under construction
LEED Silver status for student center renovation	Energy and Facilities	Lynda Rothermel, Campus Architect	Under construction
Green focus of Asset Renewal Program	Energy and Facilities	Kathy Leverton, Associate Vice President for Facilities and Administrative Services	ongoing
Higher efficiency plant chiller	Energy and Facilities	Lori Winyard, Director of Energy and Central Utilities	To be finished in late 2017.
Reinstating "Knowledge is Power" campaign	Energy and Facilities	Lori Winyard, Director of Energy and Central Utilities	Beginning Spring 2016
TCNJ Rideshare	Transportation	Brian Potter, PC3, Associate Professor Political Science	Beginning Spring 2016
Electric car charging	Transportation	Curt Heuring, PC3, VP for Administration	First eight units installed.
Connect bike routes	Transportation	PC3	In exploration
"TCNJ Bikes!"	Transportation	Bonner Scholars	One event per semester

Initiative	Emissions Category	Actor and Resources	Status
Bike repair stations	Transportation	PC3	In exploration
Improve recycling participation	Reduce Consumption	Amanda Radosti, Professional Service Specialist, PC3	Beginning February 2016
Dorm recycling events	Reduce Consumption	Bonner Scholars	Once a semester
Hydration stations	Reduce Consumption	Karen Roth, Director of Dining Services and Student Affairs Development Office	First unit installed February 2016; more to follow
Environmental Studies minor	Education, Research and Public Engagement	Diane Bates, Director and Professor of Sociology	Approved Fall 2015 and now admitting students
Environmental Sustainability Education minor	Education, Research and Public Engagement	Laura Madden, Director and Assistant Professor of Elementary and Early Childhood Education	Approved Fall 2015 and now admitting students
Public Policy minor	Education, Research and Public Engagement	Brian Potter, Chair and Associate Professor of Political Science, PC3	Ongoing; to be revised in Spring 2016.
Sustainable Jersey	Education, Research and Public Engagement	The Sustainability Institute	Ongoing; "regional hubs" project launched 2014
Awareness campaign	Education, Research and Public Engagement	TCNJ Environmental Club	Ongoing

The list includes projects across a number of emissions sources: energy and buildings, transportation, and the reduction of consumption trash and water usage. Additionally, several new academic programs and projects aim to increase awareness and knowledge of GHG reductions in the campus community and beyond.

Finally, PC3 is beginning to look into providing resiliency against climate-change effects to the campus community and neighboring areas. However, this initiative is at a very early stage and the goals and resources to achieve them have yet to be decided.