2018 Duke University Climate Action Plan Update
November 2, 2018

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Executive Summary

The world has seen unprecedented change since Duke University made the ambitious commitment to being carbon neutral by 2024. A decade ago, the University thought carefully about selecting this target. Duke wanted to balance short- and long-term financial implications with the desire for near-term action that could have a more significant effect on global climate change. The University also considered years that have a particular significance beyond greenhouse gas (GHG) emissions to further engage the campus community. As such, the year 2024, the 100th anniversary of the James B. Duke’s Indenture of Trust, emerged as a date with special significance to the campus that also fit into other evaluation criteria.

Through the work of numerous campus stakeholders, the University has seen impressive progress towards the 2024 goal with a 24% reduction in greenhouse gas emissions since the 2007 baseline. Even as Duke has grown over 3 million gross square feet (GSF) in this timeframe, emissions per GSF have fallen 39%. These emissions reductions have come primarily from investments in energy efficiency, moving off of coal in the campus steam plants and Duke Energy reducing the carbon content of its electricity. Transportation emissions have proven harder to impact given the personal nature of these decisions and a lack of regional infrastructure.

After reviewing all aspects of the 2009 Climate Action Plan, assessing future needs of the campus and working with the Campus Sustainability Committee and other stakeholders, Duke University has developed the 2018 CAP Update. This update focuses on internal emission reductions for energy and transportation and how education, communication, and carbon offsets will continue to be incorporated into achieving the 2024 goal. The University has also developed new projections for emissions out to 2024 to guide future decisions and investment. If all elements of the 2018 CAP Update are implemented as recommended, the University would be at an estimated 84% reduction of total greenhouse gas emissions by 2024, with approximately 55,000 MTCO2e left to address using carbon offsets (Figure 1 below).
The emission reductions modeled in the graph above are ordered based on the University’s ability to implement and control. While Duke fully intends to pursue off-site solar and biogas, external factors will impact the timing, cost and procurement options. Note that the biogas purchase modeled in the projections is based on the amount necessary to offset natural gas used in campus steam plants. Replacing approximately 10% of the fuel used in the campus steam plants in addition to associated carbon offsets would make the plants carbon neutral. Neutrality results from a combination of the capture and destruction of the biogas that would have been emitted into the atmosphere plus the displacement of conventional natural gas that would have been used to fuel the campus steam plants. If Duke made a larger biogas purchase it could potentially make the entire campus carbon neutral or even “carbon positive,” as the University would reduce more carbon in the atmosphere than it releases. However, Duke will continue to focus on reducing on-campus emissions and on developing a diversified portfolio of carbon offset projects to minimize risk and to ensure the campus continues to meet its carbon neutrality goal into the future.

With six years remaining until the 2024 target for neutrality and being on the heels of the recent, alarming Intergovernmental Panel on Climate Change (IPCC) report that put in stark terms the consequences inaction could have on the planet and human society, Duke’s imperative is even more critical to meet or exceed this goal. Duke’s leadership recognizes that making its campus climate neutral will not even register a minor change in global greenhouse gas emissions. However, this institution, with its focus on innovation, public service and global connections, is uniquely situated to be an example of climate leadership and instill this ethic in all students. If Duke University can harness its faculty expertise and student passion while offering a concrete example of how a complex institution tackles climate neutrality, it can have far reaching effects on the surrounding community, the region and the world.
CAP Introduction and Background
In 2007, President Brodhead signed the American College and University Presidents’ Climate Commitment (ACUPCC), which led to the development of a plan for carbon neutrality for Duke University. This commitment is a part of Duke’s deep-rooted belief that the University has the duty to put knowledge in the service of society to address local and global issues.

This led to the formation of a standing, presidentially-appointed Campus Sustainability Committee (CSC) comprised of faculty, staff, and students, which is currently co-chaired by Tallman Trask, Executive Vice President, and Toddi Steelman, Dean of the Nicholas School of the Environment. The CSC and numerous other stakeholders worked diligently for two years to develop Duke’s comprehensive Climate Action Plan (CAP) outlining the strategies and opportunities for the campus to meet the aggressive 2024 target for carbon neutrality. The plan was endorsed by the Board of Trustees in October 2009.

The CSC reports progress toward the CAP and broader efforts to include other key topics such as water, waste, food, natural resources, procurement and sustainable investment in the annual Sustainability Strategic Plan (SSP).

Emissions Overview
The CAP breaks down Duke University’s overall emissions into three distinct categories to define and address the unique attributes and scope of each (also shown in Figure 2):

- **Scope 1:** Direct GHG Emissions from:
  - Fuel used on campus for heating generation
  - Fuel used in Duke-owned vehicles
  - Fertilizer used on Duke grounds
  - Refrigerants

- **Scope 2:** Indirect GHG emissions from:
  - Electricity purchased from Duke Energy

- **Scope 3:** Other Indirect GHG emissions from:
  - Employee commuting
  - Air travel paid for by the university
  - Landfilled waste
  - Fugitive emissions from natural gas extraction and transport (added in 2017)
  - Transmission losses from purchased electricity (added in 2017)
In addition, criteria have been established to define the types of facilities included within scope for the CAP. The criteria focuses on which entities Duke University has direct operational control over. Figure 3 below summarizes which entities are included in the Climate Action Plan goals.

**Figure 3: Duke University’s entities that are included in CAP goals**

To date, Duke University has made significant progress in meeting CAP goals with an overall 24% reduction in greenhouse gas emissions since 2007. During this same time, Duke University increased campus building space included in the CAP by approximately 3 million square feet (25% increase since 2007). When calculating emissions per square foot, the reduction is nearly 40%. See Figure 4 for graphical comparison.

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*Other includes emissions from fertilizer and refrigerant use.*
Emissions reductions have been achieved mainly by energy-related reduction strategies including the following:

- discontinuing the use of coal in the campus steam plants
- investment in energy efficiency and utility plant improvements
- Duke Energy reducing the carbon content of its electricity

These strategies have reduced energy-related emissions despite significant campus growth. Emissions from transportation sources such as employee commuting and air travel have proven harder to influence due to external factors such as where employees choose to live, fluctuating gas prices, and limited regional transportation infrastructure. As shown in Figure 5 below, the breakdown of the trend for emissions includes a reduction of 36% from steam generation on campus, a reduction of 38% for electricity emissions, and an increase of 9% in transportation-related emissions compared to the 2007 baseline.
While Duke is proud of the substantial progress made on the 2009 CAP strategies, it is prudent to critically assess past efforts and develop an updated CAP with only six years left before the 2024 target. This update evaluates emission reduction efforts to-date and assesses new technology and policies that will facilitate meeting the 2024 goal. This update also provides an opportunity to engage student interest and faculty stakeholders in a productive discussion of Duke’s climate goals and the broader global issues facing our rapidly warming world.
2018 Climate Action Plan Update Principles

As part of the 2018 CAP Update, Duke University has developed a statement of principles on energy and climate change that will guide its pursuit of climate neutrality. These principles are based on the University’s longstanding commitment to sustainability and climate leadership.

In deliberating new programs and investments towards climate neutrality, Duke University will:

- Consider the full economic, social, and environmental impact of all potential emission reduction projects.
- Strive to meet the campus energy and energy security needs with the fewest greenhouse gas emissions and greatest environmental benefits economically feasible.
- Support investment in renewable energy and renewable energy technologies while continuing to prioritize and invest in energy-efficiency measures as part of its greenhouse gas reduction efforts.
- Prioritize investment in emission reduction and carbon offset projects that benefit the environment and economy of local communities.
- Advocate for policies at the local, state, and federal levels that expand access to and affordability of renewable energy.
- Support investment in local infrastructure that would provide opportunities for the campus community to access viable options for alternative transportation.
- Utilize Duke’s commitment to climate neutrality in ways that will lead to the adoption of climate change solutions at a larger scale.
- Continue and expand Duke’s commitment to make knowledge of sustainability and climate neutrality part of the educational experience of all students.
- Identify and effectively engage with stakeholders both on and off campus.

Using these principles, the Campus Sustainability Committee and other stakeholders have developed the 2018 CAP update with a focus on energy and transportation internal emission reductions and how education, communication, and carbon offsets will be incorporated into achieving the 2024 goal.
Energy

Overview
The Duke University main campus has one of the largest utility networks in the southeastern U.S. The University manages heating, cooling, and electricity infrastructure for over 20 million square feet of buildings on Duke’s main campus in Durham, North Carolina. Duke’s annual energy use is almost evenly split between electricity (51%) and natural gas (49%) and was over 3 million MMBTU in 2018. Depending on the utility system, Duke University uses the equivalent energy and water of 10,000-40,000 typical residential homes (Figure 6).

Figure 6: Scale of Duke University’s Campus Utilities

Currently, Duke University purchases electricity from Duke Energy and natural gas from PSNC Energy. Steam and hot water, which are produced by burning natural gas in two thermal energy plants on campus, are used for space heating, sterilization, humidification, de-humidification, and domestic hot water in university buildings, laboratories, clinics, and Duke University Hospital. Electricity is used for lighting, plug-in devices, and air conditioning.

Duke’s utility infrastructure consists of the following:
- 2 chilled water plants
- 2 steam plants
- 1 solar hot water plant
- Approximately 1 MW of solar photovoltaics (PV)
- 1 district hot water plant
- 5 high voltage electrical substations
- 3 central emergency generator plants
- 2 stormwater plants
- Hundreds of miles of underground pipes and wire
Duke University receives nearly all of its electricity needs from Duke Energy and this electricity accounted for 40% of Duke University’s emissions in 2018. Since 2007, Duke Energy has reduced its emissions per megawatt-hour by 36% by changing its fuel mix. From 2005 to 2017 the percent of coal-fired generation decreased and was replaced by expansions of natural gas-fired generation and renewable energy. Duke Energy plans to invest $11 billion in continued expansion of natural gas fired generation and renewable energy in the future. See the Figure 7 to see how emissions have changed since 2007 and how they are projected to change through 2035.

Figure 7: Duke Energy Historical and Projected Carbon Intensity (MTCO2e/MWh)

Renewable Energy on Campus

Duke University has explored and invested in renewable energy projects as part of its strategy to reduce carbon emissions on campus while meeting growing energy needs. As of fall 2018, Duke has 900 KW of solar photovoltaics (PV) and hot water (shown as equivalent kW) installed in the following locations:

- Bryan Center - 80 kW solar hot water
- Smart Home - 10 kW solar PV
- Grainger Hall - 45 kW solar PV and 15 kW solar hot water
- Research Drive Parking Garage - 750 kW solar PV

However, the use of renewable energy for the scale of University operations and energy needs is constrained by regulatory and economic factors.
Regulatory and Economic Constraints for Renewable Energy at Duke University

Due to N.C. law, electricity can only be sold by investor-owned utilities (e.g. Duke Energy) and electric membership corporations (EMCs). This limits the ability for Duke University to enter into Power Purchase Agreements (PPA) for off-site renewable energy generation. However, regulation proposed in late 2017 in the N.C. General Assembly may open new solar opportunities for Duke University by early 2019. University officials are closely following the North Carolina HB589 as it may be an opportunity for Duke University to build economically feasible, large-scale solar off-campus that has not previously been an option.

Under review by the North Carolina Utilities Commission as of October 2018, Duke Energy has proposed a utility-scale renewable energy procurement program called “Green Source Advantage (GSA)”. This program will be available to nonresidential customers who have energy demands of at least 1 MW of peak demand at a single location, or an aggregate of 5MW or more of peak demand across multiple locations. There will be up to 600 MW of total capacity, with 100 MW for military installations, 250 MW for The University of North Carolina institutions, and 250 MW set aside for other large nonresidential customers (e.g. Duke University). Customers can choose to purchase any amount up to 125% of their maximum annual peak demand, which for Duke University would be 125% of 81.6 MW, or just over 100 MW with the potential to reduce Duke’s carbon footprint by approximately 33,000 MTCO2E.

The program will be on a first-come-first-served basis, so it is not guaranteed that any of Duke University’s 100 MW capacity, through this policy, will be available for the University. Beyond this program, which would allow Duke University to source approximately a third of purchased electricity from renewable sources, there are not currently any regulations that permit off-site renewable power purchases. However, the University is committed to purchasing large amounts of off-site solar if it becomes available.

With regards to electricity alone, the University requires electrical power around the clock, and unfortunately, solar photovoltaic systems can’t generate at night, nor are they steady in output. Energy storage is also not economically feasible to make up the balance of energy needs. Facilities Management has studied, and continues to study, options for integrating renewable energy into the campus supply mix.

Within the campus energy profile, it should be noted that almost half the energy used on campus is to produce steam or hot water. Solar and other renewables, do not offer cost effective options for producing this thermal energy. The University is actively exploring, methane-capture biogas as a renewable option to produce steam on campus.

A final limiting factor to making solar and other renewables more cost effective for the university is the tax-exempt status of the institution. Unlike residential or commercial customers in N.C., Duke University’s nonprofit status means it is not directly eligible for potential state or federal tax rebates connected to renewables, which can have a significant impact on the overall cost of a project.
2009 CAP Energy Recommendations Update

When Duke University first established its carbon neutrality goal, approximately 78% of emissions came from energy-related sources. These sources included fuel burned in the campus steam plants and purchased electricity. The 2009 Climate Action Plan set clear goals and recommendations to reduce this footprint.

1. Establish green building energy consumption standards and an approval protocol for building energy consumption review -- implement, measure and report on energy use targets by Building Tech Rating.

2. Beginning in 2010, implement energy conservation measures in existing buildings with the goal to realize a 15% reduction in energy use over a 20 year period (2010 – 2030).

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


5. Research alternative technologies and explore and implement conversion to biogas, solar PV, solar thermal, combined heat and power or other technologies by 2030.

6. Pursue plant efficiency improvements such as distribution system upgrades, thermal storage, chilled water expansion and upgrade, and boiler plant heat recovery.

The implementation of previously discussed strategies has significantly reduced the University’s overall energy-related greenhouse gas emissions. Duke University also added fugitive emissions from the production of natural gas used in campus steam plants and transmission losses from purchased electricity to the greenhouse gas inventory in 2017.

In 2018, 69% of Duke University's greenhouse gas footprint came from energy-related emissions (approximately 176,000 MTCO2e), 58% of energy-related emissions came from purchased electricity, 36% from fuel burned in campus steam plants and 6% from fugitive emissions and transmission losses. Since 2007 energy-related emissions have been reduced by 37%, despite campus growth of over 3 million GSF (Figure 8).
In the spring of 2018, Duke University made the decision to develop an Energy Needs Analysis to identify ways to reduce emissions while meeting the energy needs of a growing campus and health system.

**2018 Energy Needs Analysis**

Duke University works diligently to efficiently and reliably meet the energy needs of a growing campus with complex academic, research, and health care operations. The 2018 Energy Needs Analysis ([full-report available](#)) assessed the current loads and production/distribution assets, ability to recover or adjust easily to an unforeseen event or outage (resiliency assessment), and the impact of future loads on the systems. The following utility systems were assessed: Chilled Water, Steam, Hot Water, Electrical Power, City Water, Reclaimed Water, and Natural Gas.

Each of the utility systems were assessed for their current ability to meet the following system needs:

- Utility Resiliency and Reliability
- Near-Term Utility Infrastructure Upgrades
- Growth in Campus Energy Needs
- Carbon Reduction Goals

Low carbon alternative fuel sources such as biogas and solar photovoltaics were also considered for use in these systems.
The study found there are several solutions that could be implemented to satisfy the system needs identified previously. The basic description of these options is noted below:

- **Separate Heating and Cooling** (SHC) – Business as usual case, with separate heating and cooling plants, plus continuous duty central generating plant for standby power system needs.
- **Combined Heat and Power** (CHP) – Simultaneous generation of heat and power to meet a large portion of the standby power system needs as well as heating system needs. Provide separate chillers to meet cooling system needs.
- **Combined Heating and Cooling** (CHC) – Simultaneous generation of heating and cooling using Heat Recovery Chillers (HRC) to satisfy heating and cooling need for a portion of campus. Additional heating, cooling and packaged generators are required to meet additional system needs.

These design options are not mutually exclusive and a combination of the options could also be utilized in a **Hybrid Generation** (HYGEN) system.

The Energy Needs Analysis assessed the economic, carbon and utility impacts for numerous scenarios with the technologies referenced above. The following is a brief overview of the options that were evaluated for campus hot water, steam, chilled water and stand-by power.

**Steam and Hot Water**
Steam and hot water are used for space conditioning, hot water heating, hospital medical equipment sterilization, dining services, pool heating, dishwashing and other process uses. The university has recognized a need to replace some aging and inefficient infrastructure on campus, address future campus growth, and provide a backup source of steam in case of emergencies, including limited supply of fuel or a city-water outage. Some technologies that can be used to meet these needs include:

- **Steam**
  - Gas-fired boilers to produce steam, which could be fueled by biogas.
  - Co-generation of power with hot water and/or steam produced from waste heat.
  - Electric boilers to produce steam, which can partially be supplied by solar PV.

- **Hot Water**
  - Heat exchangers used to produce hot water from steam produced in existing boilers.
  - Co-generation of power with hot water and/or steam produced from waste heat.
  - Heat produced by Heat Recovery Chillers during the production of chilled water.

**Chilled Water**
The centralized production and distribution of chilled water is the most efficient and economical method to cool Duke University’s campus, including the Schools of Medicine and Nursing and Duke Hospital. The system provides chilled water for process equipment cooling and building air conditioning in a reliable and cost-effective manner. The university recognized
a need to ensure reliable chilled water in case of emergencies such as electricity/city-water outages. Technologies that can be used to meet these needs include:

- Diesel generators distributed across campus to support particular buildings/systems.
- Co-generation of power with hot water and/or steam produced from waste heat.
- Thermal energy storage tank where chilled water is produced at night when electricity demand is lower and then used during the day.

**Standby Power**

Electricity is central to the generation of chilled water and powering of Duke’s complex research and medical facilities. The university has recognized a need to ensure that electricity is available in cases of emergencies to provide reliable backup power and chilled water for campus. Some technologies that can be used to meet these needs include:

- Diesel generators distributed across campus to support particular buildings/systems.
- Co-generation of power with hot water and/or steam produced from waste heat.
- Batteries that store power and discharge when needed.

Of the options above, battery storage and electric boilers are not considered feasible at the current time due to prohibitive cost. A full description of all reviewed technologies is publicly available in the Energy Needs Analysis Report.

**Energy Needs Analysis Conclusions and Next Steps**

Duke will continue to build upon the results of the 2018 Energy Needs Analysis to develop a detailed Utility Master Plan that establishes the major projects, timeline, and costs for proposed projects. This energy analysis has shown that no single technology or system approach effectively meets all of the complex campus and health system needs. Solutions must be tailored to the unique differences of parts of campus, and the operability of technologies is critical to maintaining a high level of system reliability.

Based on the analysis all of the technologies deemed feasible over a 30-year life cycle, each option is within 5% difference in cost from one another. The University can also best manage annual utility investments by making incremental improvements to systems versus a wholesale implementation of a single system.

The study also found that no single on-campus technology makes a significant impact towards carbon reduction goals. Duke University will continue to make on-campus reductions and investment in on-campus renewables to maximize internal carbon reductions, but only off-campus, large-scale solar and methane-capture biogas have the potential to drive energy emissions to zero.
Biogas Overview

History
Starting in 2009, the Duke Carbon Offset Initiative (DCOI) led a partnership with Duke Energy, later joined by Google, to demonstrate a full-scale swine waste-to-energy system in Yadkin County, North Carolina. The system captures biogas that is produced from the breakdown of hog waste in the farm’s anaerobic digester. The biogas, comprised of approximately 65% methane, is conditioned and then burned in an onsite microturbine to generate electricity. Notably, the system also meets all of the state’s environmental performance standards for new and expanding farms. Duke University and Google receive credit for the greenhouse gas emission reductions or carbon offsets that result from the capture and destruction of the biogas, while Duke Energy receives renewable energy certificates for the electricity produced from the biogas. The project is important because it proves the efficacy of harvesting biogas for energy generation and carbon reductions through systems such as the one in place at the Loyd Ray Farms. It also served as the basis for a roadmap produced by the Nicholas Institute for Environmental Policy Solutions and the DCOI for swine waste-derived biogas development for compliance with the state’s Renewable Energy and Energy Efficiency Portfolio Standard’s swine waste carve-out. The Yadkin County system provided data that Duke University used to model a way to scale energy production from animal waste from a single-system approach to a multi-farm, network approach that would reduce biogas development costs while increasing its energy production potential.

Renewable Natural Gas Focus
Together, the Loyd Ray Farms project and follow-on analysis have served as the starting point for wide scale biogas development which the University hopes will expand into other sectors such as poultry, dairies, crop residues, food waste, and waste water treatment plants. The basic idea is that biogas captured during the breakdown of waste can be refined and turned into renewable natural gas or RNG that in turn can supplant the use of fossil-derived natural gas. A focus on methane, which is the primary component of natural gas, means that a greenhouse gas estimated to be 34 times more potent than carbon dioxide is being mitigated, and instead of simply being destroyed or flared it is being converted into a renewable fuel source.

The University has been particularly drawn to carbon reductions and biogas/RNG derived from swine farms because North Carolina is the second largest pork producer in the nation and the high population of farms makes North Carolina a leader in methane emissions from livestock operations. Plus, livestock operations – including hog and dairy operations - qualify for methane reductions under the Climate Action Reserve’s Livestock Methane Protocol and can produce RNG, thereby providing a double dividend in terms of methane destruction (for carbon offsets) and RNG production (for powering campus steam plants).

It is worth noting that Duke’s initial plans for biogas were limited to its capture and destruction, which yields carbon offsets and would allow Duke to offset those emissions that it cannot reduce on campus. Due to technological advancements brought about in part by the Loyd Ray
Farms project and policy changes, Duke University began to consider directed biogas as replacement for traditional fossil natural gas.

**Current Efforts**

Biogas fits into the University's energy plan as a way to meet a portion of the campus energy needs via a renewable fuel source, capture greenhouse gas emissions that would otherwise be released into the atmosphere at livestock operations, and help North Carolina improve livestock waste management. Specifically, waste from livestock farms can be anaerobically digested. Then, the biogas can be captured, refined, turned into RNG, and injected into the existing natural gas delivery infrastructure where it can be used to fuel campus steam plants that provide steam and hot water across the University facilities. Because the University is limited via regulations in the amount of renewable power it can obtain and because nearly half of the University runs on natural gas, biogas is an important option for Duke University to run directly on a renewable fuel source.

The University is actively pursuing the purchase of renewable natural gas from developers of livestock methane projects at levels that would initially provide carbon offsets for all natural gas used in campus steam plants and potentially play a significant role in the University’s strategy to achieve climate neutrality in 2024 and subsequent years.

**2018 CAP Energy Recommendations**

**Objective 1: Maximize opportunities for building energy efficiency and low carbon new construction (demand-side initiatives).**

1. Continue to invest in the energy efficiency of existing campus buildings with strategies such as HVAC optimization through building retro-commissioning, building analytics upgrades, and efficient technology such as LED lighting retrofits with a goal of 20% reduction by 2024.
2. Continue to pursue Energy Use Intensity (EUI) targets for new construction and finalize the Duke Sustainable Building Framework. Consider opportunities to better track and monetize the carbon impacts of new construction to inform future campus planning.
3. Further develop initiatives to educate schools, departments and individuals on campus about their energy use and opportunities for conservation.

**Objective 2: Expand campus utility infrastructure to meet energy needs in the most economically and carbon efficient way (supply-side initiatives).**

1. Continue district hot water conversion in buildings that do not require high temperature steam. Utilize solar thermal technology where feasible in conjunction with new campus hot water plants.
2. Continue to pursue plant efficiency improvements with tactics such as: east-west steam line retirement and chilled water efficiency through technologies such as thermal energy storage.
3. Install heat recovery chillers in the renovation of East Campus dorms to include air conditioning.
4. Implement additional on-campus solar systems to meet 4MW goal.

**Objective 3: Leverage off-campus initiatives for high-impact renewable energy.**

1. Support and foster the development of a renewable biogas market in North Carolina that reduces reliance on fossil fuels at Duke University and provides opportunities for positive community, environmental, economic, and policy outcomes in the state.
2. Continue to advocate for regulatory and policy changes in N.C. that would allow Duke University greater freedom over campus energy options. Seek collaborations with other similarly situated institutions to further amplify efforts.

If Duke University implemented the recommendations and specific strategies above to reduce energy-related greenhouse gas emissions, it is projected that overall energy emissions could be approximately negative 20,000 MTCO2e in 2024 (see Figures 9 and 10 below). This includes the offsets generated by destroying methane when burning biogas as a renewable fuel.

**Figure 9: Potential energy emission reductions through 2024**
### Figure 10: 2018 CAP Energy Carbon Reduction Plan

#### 2018 CAP Energy Carbon Reduction Plan

<table>
<thead>
<tr>
<th>Buildings / Demand-Side Initiatives</th>
<th>Low</th>
<th>High</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVAC Optimization</td>
<td>5,700</td>
<td>7,000</td>
<td>500K GSF of building space HVAC recommissioning per year</td>
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<td>LED Lighting</td>
<td>3,300</td>
<td>4,000</td>
<td>31 university buildings totaling 2.9M GSF</td>
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<td>New Construction Efficiency</td>
<td>2,000</td>
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<td>Improvements from original business as usual</td>
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**Buildings / Demand-Side Total**: 11,000 13,400

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<tr>
<td>District Hot Water Conversion</td>
<td>7,200</td>
<td>8,800</td>
<td>Continued conversions of non-research/medical buildings</td>
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<td>Cogeneration</td>
<td>TBD</td>
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<td>If deployed, would depend on size, operation, &amp; fuel</td>
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<td>Solar PV</td>
<td>1,800</td>
<td>2,200</td>
<td>Up to 4MW total on-campus installations</td>
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<td>Solar Hot Water</td>
<td>1,100</td>
<td>1,400</td>
<td>Installations at new hot water plants</td>
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<td>Heat Recovery Chillers (East Campus)</td>
<td>2,700</td>
<td>3,300</td>
<td>Assumes renovated dorms on East Campus</td>
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<td>Central Campus buildings removal</td>
<td>1,100</td>
<td>1,400</td>
<td>BOT Task Force determining future use of CC land</td>
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<td>East-West steam line retirement</td>
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<td>1,800</td>
<td>Accounts for 5-7% of all system losses</td>
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<td>Chilled Water Efficiency Improvements</td>
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<td>4,700</td>
<td>Thermal Energy Storage &amp; other actions TBD</td>
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**District Energy / Supply-Side Total**: 19,200 23,600

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<td>On Campus Total</td>
<td>30,200</td>
<td>37,000</td>
<td>Represents approximately 19% of current inventory</td>
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<th>Off Campus Actions</th>
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<th>Comments</th>
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<tr>
<td>Duke Energy GHG reductions</td>
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<td>28,600</td>
<td>Based on Duke Energy’s current estimates</td>
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<td>Utility scale solar PPA</td>
<td>46,800</td>
<td>57,200</td>
<td>Based on max. allowable under current law of 104MW</td>
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<td>Biogas supply</td>
<td>90,900</td>
<td>111,100</td>
<td>153K - 187K decatherms of animal waste biogas</td>
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**Off Campus Total**: 161,100 196,900

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<th>Grand Total of Planned Reductions</th>
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<th>High</th>
<th>Comments</th>
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<td></td>
<td>191,300</td>
<td>233,900</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>2024 BAU Energy-Related Total GHG</th>
<th>Low</th>
<th>High</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>187,100</td>
<td>192,700</td>
<td>Low growth at 1%, high growth at 1.5%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Current Total Energy-Related GHG</th>
<th>Low</th>
<th>High</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>176,300</td>
<td></td>
<td>At end of fiscal year 2018</td>
</tr>
</tbody>
</table>
Transportation

Overview
Transportation is central to the function of Duke University, whether it is the nearly 700 Duke-owned vehicles that travel around campus each day, the commuting of thousands of employees to and from work or flights to conferences, research sites, and athletic events. Each of these activities has an emissions impact that is included in Duke’s climate action goal of carbon neutrality by 2024. As of fiscal year 2018, transportation-related activities account for nearly 79,000 metric tons or 31% of Duke’s overall emissions.

During the last decade, Duke has made many efforts to reduce transportation emissions, including the hiring of two transportation demand management employees, advocacy for regional alternative transit options, and development of employee-based programs for carpooling, biking, and regional bus transit. However, due to the lack of a culture of public-transportation in Durham area and the personal nature of commuting and air travel decision-making, it has been difficult to reduce emissions. Despite the efforts above to impact emissions from transportation-related activities, emissions have increased by 9% compared to the 2007 baseline.

Figure 11 below shows that emissions from employee commuting have increased by 46%, Duke-owned vehicle emissions increased by 8%, and emissions from air travel have decreased by 15% compared to a 2007 baseline.

Figure 11: Historical transportation emissions per emission category

* In 2017, the emission factor for air travel was updated from .00077 mtCO2e/mile to .00048 mtCO2e/mile to reflect improved efficiency.

During the same time frame, the number of employees working for the University, School of Medicine, and School of Nursing has increased by 14%, employees are living 3 miles farther away on average (compared to 2007), the number of students has increased by 17%, and
vehicles and aircraft have become more fuel efficient. However, the emission increases seen from population growth and distance travelled are outpacing these fuel efficiency improvements.

The following sections highlight the progress towards the 2009 CAP recommendations and outline new recommendations from the transportation subcommittee of Duke’s Campus Sustainability Committee to further decrease campus transportation emissions. It is important to note that the purchase of carbon offsets for these harder to control emissions could be important in the near future. Based on research by the Duke Carbon Offsets Initiative, an average cost of a carbon offset is between $8-15 depending on the project type and environmental, economic, and social co-benefits associated with the project. Therefore, decisions regarding the financial investment in alternative transportation initiatives should also weigh the costs of offsetting these emissions in 2024 and beyond.

**2009 CAP Transportation Recommendations Update**

When Duke University first established its carbon neutrality goal, approximately 21% of emissions came from transportation-related sources. This included emissions from employee commuting, air travel, and Duke-owned fleet vehicles. The 2009 Climate Action Plan set clear goals and recommendations to reduce this footprint.

- Duke should develop a comprehensive Transportation Demand Management program to incentivize alternative transportation use.
- Duke should study whether an affiliated housing program at Duke University would incentivize employees to live closer to campus.
- Duke should engage on regional transportation issues such as regional transit, light rail/bus rapid transit services, and regional bike routes.
- Duke should create a better mechanism for tracking annual employee air travel emissions impact.
- Duke should develop air travel emissions impact reports for departments based on actual use.
- Duke should market and increase use of technology that enables virtual meeting to replace air travel needs.
- Duke should establish a “Green Policy” for fleet replacement to ensure that purchased vehicles are efficiency and appropriately sized.
- Duke should replace 10 diesel-fueled buses with 60-foot articulating, hybrid buses.
- Duke should encourage the utilization of local/regional transit through transit pass subsidy, advocating for improved local transit service and eliminating redundant service.
2018 CAP Transportation Recommendations

Objective 1 - Reduce emissions from daily employee commuting.¹

In fiscal year 2018, Duke University’s employee commuting contributed over 40,000 metrics tons of carbon dioxide equivalent, which is 16% of Duke’s total emissions included in the annual inventory. According to the annual transportation survey, a majority of this is the result of more than 80% of university employees driving alone to work (see figure 12 below for complete mode share breakdown). However, over the last 10 years, the average drive alone rate has been 74%, which shows that 2018 may be an atypical year.

Figure 12: Duke University’s employee commuting mode share (2018)

Duke has developed a variety of programs, which encourage the use of alternative transportation such as carpooling or walking. These programs include improvements in carpooling and vanpooling options, provision of subsidized transit options, and increases in the cost of parking on campus. Despite these programs, drive alone rate and commuting emissions per employee have increased over time as shown in Figure 13 below.

¹ Per Duke University’s Climate Action Plan, only emissions from University employee commuting are included in the annual greenhouse gas (GHG) inventory. Therefore, emissions from student and Duke University Health System (DUHS) employee commuting are not included. However, recommendations that improve employee commuting options are also likely to convey to students and DUHS employees.
Enhance public transit access
  ○ Advocate for local transit options (e.g. regional light rail, efficient bus routes, etc.) that connect employees to Duke University.
  ○ Develop targeted marketing of local transit routes and programs for employees.
  ○ Continue the subsidized Go-Pass program for Duke employees and students.

Carpooling and Vanpooling
  ○ Develop targeted marketing and incentives for Duke’s carpooling and vanpooling programs to employees who live in dense clusters.
  ○ Develop department-specific marketing campaigns and potential incentives to promote carpooling and vanpooling programs.
  ○ Expand marketing or potential incentives for https://www.sharetheridenc.org trip planning platform to employees.

Biking and Walking
  ○ Adopt and implement a Duke-based policy that considers infrastructure for cyclists/pedestrians during new construction and large building renovation projects.
  ○ Further integrate local bike-share programs on campus when demand increases.
  ○ Improve access to various bicycling/walking amenities on campus including increased safety lighting, showers and locker facilities, covered bike racks or cages, and short-term bike storage for returning students.
Advocate for increased presence of sidewalks and bike lanes in high traffic areas off/near campus.

Develop targeted marketing on the benefits of biking and walking to employees who live 0-3 miles from campus.

**Other Recommendations**

- Create a Transportation Infrastructure, Accessibility, and Sustainability Fund where a portion of student and employee parking fees go towards development of alternative transportation programs on-campus and carbon offsets.
- Develop additional flexible parking options, including monthly or semester-long parking passes and a parking cash-out program.
- Develop an employee-based benefits program for the purchase of electric vehicles, which could include partnering with local dealerships to provide PERQs-related discounts and provide competitive financing options through Duke Federal Credit Union for electric vehicles. Consider subsidized/free parking for EVs on campus.
- Expand support and emphasis on telecommuting and flexible work schedules.
- Consider a month-long opportunity for current employees to try alternative commuting with a subsidized parking pass incentive.
- Develop a network of current alternative commuters, which could serve as ambassadors to employees willing to try alternative options.
- Increase parking rates to reduce demand for parking on campus.
- Develop affordable, Duke-affiliated housing on/near campus for staff, faculty and graduate students.
- Conduct behavioral psychology research to understand what incentives/disincentives would be more effective to increase the use of alternative transportation.

**Objective 2 - Reduce emissions from Duke-owned vehicles**

Duke University owns and operates a fleet of vehicles that range from the buses that transport students, staff, and faculty around campus to trucks and cars used by Duke Facilities Management Department and Duke Police. Duke has opportunities to reduce the impact of campus fleet by purchasing vehicles that are more efficient or utilize alternative fuels such as electricity. Some progress has already been made on this evolution of fleet vehicles. Duke has replaced several buses with hybrid models and is in the process of acquiring two full-electric buses in 2020. In fiscal year 2018, Duke University’s fleet contributed 3,600 metrics tons of carbon dioxide equivalent, which is 1% of Duke’s total emissions included in the annual inventory. Below are recommendations to reduce emissions from Duke-owned vehicles.

- Assess ridership on all Duke bus routes to reduce redundancy and improve access.
- Conduct a study that compares conventional fuel vs electric for entire Duke fleet.
- Explore electrification of all Duke buses and vehicles.
- Implement a Green Fleet purchasing program, which sets a target for fuel efficiency and develops a list of hybrid or electric options for purchase through approved vendors.
Create a form to be filled out prior to the purchase of a new vehicle, which clarifies whether a vehicle is actually needed and the possibility of purchasing a smaller, more efficient or alternatively fueled vehicle.

**Objective 3 - Reduce emissions from university-sponsored air travel**

Duke University includes emissions from domestic and international air travel that is paid for or sponsored by the university. This includes travel from Duke Athletics, travel to conferences and research sites, and flights through DukeEngage. In fiscal year 2018, Duke University’s air travel contributed 35,000 metrics tons of carbon dioxide equivalent, which is 14% of Duke’s total emissions included in the annual inventory. Over the past ten years, aircraft have become much more fuel efficient leading to an overall emissions reduction of 15% compared to 2007. However, the number of miles flown by Duke employees has increased nearly 20 million miles (a 36% increase from 2007). Reducing the impact of air travel can be difficult since travelling is central to faculty research, study abroad, and sharing of information at conferences, which are all important and necessary university functions. However, below are recommendations to make travel as efficient as possible.

- Streamline data collection on air miles traveled to estimate emissions impact.
- Share departmental reports that outline cost and emissions impact of air travel.
- Market programs like TripZero, which offset emissions associated with air travel and hotel stays.
- Develop a preferred airline carrier list based on sustainability metrics including options to purchase carbon offsets and use of biofuels in aircrafts.
- Consider options for distributing the cost of travel offsets to departments based on use.
- Create marketing about time and cost of air travel to destinations and compare alternatives (carpooling, train, bus, and teleconferencing).
- Encourage the consolidation of multiple meetings during a single trip by aircraft.
- Encourage the use of teleconferencing for meetings in other states or countries, particularly meetings that occur regularly.

**Summary of 2018 CAP Transportation Recommendations**

Overall emissions from transportation-related activities have risen by 9% compared to Duke’s 2007 emissions baseline. Total transportation emissions were 79,000 MTCO2e in fiscal year 2018 (July 1, 2017 - June 30, 2018). Employee commuting accounted for 51%, air travel accounted for 44%, and fleet accounted for 5% of total transportation-related emissions at Duke.

Recommendations to reduce these emissions are summarized below and are sorted based on estimated financial and internal emission reduction impact (see figures 14, 15, and 16). The cost and impact estimates do not fully encompass all potential costs and benefits of each recommendation. The financial impact only considers costs and savings to Duke University and not costs or savings to individual employees. The emission reduction impact only considers emissions that are included in Duke’s greenhouse gas inventory and therefore do not include all
other benefits that could be associated. Note that recommendations in **bold** could be implemented in the immediate or near-term.

**Figure 14: Employee commuting recommendations**

<table>
<thead>
<tr>
<th>Low Cost and Lower Impact</th>
<th>Low Cost and Higher Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Further integrate bike share programs</td>
<td>• Advocate for regional transit improvements</td>
</tr>
<tr>
<td>• Develop a Transportation Infrastructure, Accessibility, and Sustainability Fund to go towards development of alternative commuting options and offsets</td>
<td>• Develop targeted marketing about alternative commuting for employees</td>
</tr>
<tr>
<td>• Advocate for increased presence of sidewalks and bike lanes in high traffic areas on/near campus.</td>
<td>• Develop additional flexible parking options including monthly- or semester-long parking passes</td>
</tr>
<tr>
<td>• Expand marketing of SharetheRideNC trip planning platform</td>
<td>• Develop employee-based benefits program for electric vehicle purchase</td>
</tr>
<tr>
<td>• Increase parking rates</td>
<td>• Support and expand telecommuting and flexible schedule options</td>
</tr>
<tr>
<td>• Develop a network of current alternative commuters, which could serve as ambassadors to employees willing to try alternative options.</td>
<td>• Consider a month-long opportunity for current employees to try alternative commuting with a subsidized parking pass incentive.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>High Cost and Lower Impact</th>
<th>High Cost and Higher Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Adoption and implementation of policy for cyclist and pedestrian infrastructure for new construction and major renovations</td>
<td>• Develop a parking cash out program which benefits employees who choose to use alternative commuting</td>
</tr>
<tr>
<td>• <strong>Continue subsidy of GoPass program for Duke employees and students</strong></td>
<td>• Develop affordable, Duke-affiliated housing near campus for employees</td>
</tr>
<tr>
<td>• Improve access to EV charging stations on campus</td>
<td></td>
</tr>
<tr>
<td>• Improve access to various cycling/walking amenities on campus</td>
<td></td>
</tr>
</tbody>
</table>
**Figure 15: Duke-owned fleet recommendations**

<table>
<thead>
<tr>
<th>Low Cost and Lower Impact</th>
<th>Low Cost and Higher Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Assess ridership on all Duke bus routes to reduce redundancy and improve access</td>
<td>• Conduct a study that compares conventional fuel to electric for the entire Duke fleet</td>
</tr>
<tr>
<td>• Update the new vehicle purchasing form to include questions regarding need, necessary size, efficiency of proposed options, and fuel type</td>
<td>• Implement a Green Fleet purchasing program that sets a target fuel efficiency per vehicle type</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>High Cost and Lower Impact</th>
<th>High Cost and Higher Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Electrification of buses and vehicles</td>
</tr>
</tbody>
</table>

**Figure 16: Air travel recommendations**

<table>
<thead>
<tr>
<th>Low Cost and Lower Impact</th>
<th>Low Cost and Higher Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Streamline data collection on air miles traveled to accurately estimate impact</td>
<td>• Share departmental reports that outline cost and emissions impact of air travel</td>
</tr>
<tr>
<td>• Develop a listing that ranks airline carriers based on sustainability metrics</td>
<td>• Market programs like TripZero, which offset emissions from air travel for free</td>
</tr>
<tr>
<td>• Create marketing about time and cost of air travel compared to alternatives like carpooling, train, bus, and teleconferencing)</td>
<td>• Consider options for distributing cost of carbon offsets for air travel emissions to departments based on use</td>
</tr>
</tbody>
</table>


Using conservative estimates, the recommendations in the previous sections have the potential to reduce transportation-related emissions by 2% annually. These emissions are also connected to employee growth and trends of living further way from campus. However, depending on level of investment and adoption rates of these recommendations, the impact on emissions could be greater. For example, if many employees over the next decade plan to purchase a new vehicle and Duke provides incentives to choose an electric vehicle, emissions from employee commuting could decrease much more than 2% per year. Figure 17 below shows that by 2024, an emissions reduction of 4% could conservatively be anticipated.

**Figure 17: Potential transportation emission reductions through 2024**
Carbon Offsets

Overview
Despite Duke University’s aggressive approach to reducing emissions on campus, the University expects that there will still be emissions in 2024 that need to be offset to get to the goal of zero. With this need in mind, the Offsets Subcommittee made recommendations to the CSC on ways to mitigate emissions remaining after on-campus reduction strategies have been implemented. Based on these recommendations, the Duke Carbon Offsets Initiative (DCOI) was created in 2009. Since creation, the DCOI has developed an innovative swine-waste-to-energy project, a residential energy-efficiency program, several urban forestry projects, and is in the process of developing a wetland restoration project. It has also purchased carbon credits from domestic projects, as well as projects in Guinea Bissau and Mexico.

The DCOI has supervised over a dozen student-based interdisciplinary projects, served as a client for multiple semester-long courses, and has managed dozens of student interns. Some project highlights include an 2018-2019 masters project which will examine the use of land conservation to avoid deforestation as a carbon offset project type and a Bass Connections project that created a website (solveanimalwaste.com) that connects meat consumers, producers, and advocates to information on animal waste management best practices.

Building on the success of the projects developed by the DCOI, Duke has partnered with many universities, non-profits, city governments, and businesses to expand its impact. Most notably, the DCOI led the development of the Offset Network (offsetnetwork.org), which is a website that provides access to carbon offset case studies, protocols, and general project development guidance. Another way the DCOI has catalyzed the creation of carbon offset projects in higher education is through coordination of a 15+ member committee of academic peers and offset professionals to eliminate barriers posed by verification costs or the complexity of project protocols preventing colleges and universities from developing small to medium-scale offset projects.

The DCOI, with guidance from the carbon offsets subcommittee of the Campus Sustainability Committee, has also developed a strategy for decision-making surrounding offset purchase and project development. The strategy highlights the following key objectives that are central to any carbon offset used by the university:

- Prioritize local and regional offsets that provide significant environmental, economic, and societal co-benefits beyond the benefits of greenhouse gas reduction
- Implement the strategy in a way that provides educational opportunities for students and faculty
- Facilitate and catalyze high-integrity, unique offset projects by serving as a resource for other institutions
2018 CAP Carbon Offsets Recommendations

Objective 1: Purchase and Develop Local Offsets that have Significant Environmental, Economic, and Social Benefits

When evaluating the value of a carbon offsets project, it is important to assess it on a variety of elements external to the carbon emission reduction. These elements, more commonly known as co-benefits, are the additional environmental, economic, and social benefits that also result from a carbon offset project. The DCOI developed a guidance document on offsets and co-benefits, which assists students, staff, and faculty at Duke University as well as those at peer universities. Some recommendations for expanding these efforts are below:

- Conduct an inventory of local projects with high co-benefits and/or projects
- Employ a portfolio-based approach to selection of projects
- Identify ways to scale current projects to increase impact
- Re-engage with the Offsets Subcommittee to discuss prioritization of future projects

Objective 2: Provide Educational Opportunities

Since Duke University is a leading educational institution, developing or purchasing carbon offsets should incorporate students throughout the process. Through collaboration with students and faculty at Duke University and other peer institutions, the DCOI has developed unique projects, drafted new carbon offset protocols, and purchased offsets from impactful projects. To continue building on past successes, DCOI has identified the following recommendations:

- Continue to build relationships with Duke resources for new project research and development like the Duke Marine Lab, Nicholas School of the Environment MEM Master’s Projects and Bass Connections.
- Investigate carbon offset projects that could connect students with Duke study abroad sites
- Continue to offer DCOI as a client for student projects, from single class projects to capstone and masters projects

Objective 3: Serve as a partner for peer universities

Serving as a resource to other institutions has always been a fundamental part of the DCOI’s mission. Because it is the only office in higher education focusing solely on carbon offsets, the DCOI has gained experience and knowledge that other universities may be able to use when developing their own offsets strategies. Recommendations for DCOI to continue and expand in this capacity are:

- Continue to expand the Offset Network to include new project types that universities can engage in
- Leverage Duke University resources to conduct peer verification of other universities’ carbon offset projects
Education

Overview
Duke University enrolls over 15,000 students (6,500 undergraduate students and 8,600 graduate and professional students) who come from diverse backgrounds to study many different topics during their time on campus. However, one of the overarching goals of the 2009 Climate Action Plan was focused directly on ensuring that all students at Duke graduate with a knowledge of sustainability and carbon neutrality. Through the efforts of many campus stakeholders, numerous opportunities have developed for students to engage with environmental, societal, and economic sustainability topics in the classroom and through co-curricular programs such as DukeEngage. The following section reports on a variety of initiatives that have been started since the original 2009 Climate Action Plan.

Current and Ongoing Initiatives
Over the past decade, sustainability has been infused in Duke’s academics through a variety of initiatives. Starting from student orientation, interested students are informed about ways to integrate sustainability into their academic pursuits. Then, during course selection time, Sustainable Duke develops a list of all courses that incorporate sustainability-related themes in the classroom so students can easily identify sustainable courses. Lastly, Sustainable Duke in partnership with the faculty director of sustainability have piloted a Sustainability Literacy Test for students in select courses to gauge existing knowledge. In addition to these, below are highlights from major initiatives since 2009.

Undergraduate Experiential Certificate in Sustainability Engagement
In 2016, Duke University launched a new Experiential Certificate in Sustainability Engagement for undergraduate students. This unique certificate provides students greater opportunities to use knowledge they gained in the classroom in real-world experiences. As of October 2018, the program has almost a dozen students with two students who graduated in May 2018 and 4 planned for May 2019.

Trillium Sustainability Fellows Program
The Trillium Sustainability Fellows program, modeled after the Piedmont Project at Emory University, provides an avenue for faculty to learn to infuse sustainability concepts into syllabi regardless of discipline. The Trillium Sustainability Workshop is offered annually to any faculty, staff, or students with current or future teaching responsibilities. To date, 180 faculty and staff across 17 institutions have become Trillium Fellows.

Campus as Lab
Campus as Lab (CAL) is a Sustainable Duke initiative that seeks to develop project ideas and solutions to global and local issues by using Duke University’s campus and the local Triangle
area as a living laboratory. A CAL project connects students, faculty, and staff together to explore new ideas, carry out experiments, and create solutions to sustainability issues by utilizing sites on campus such as the Duke Forest, the Duke Reclamation Pond, or the Student Wellness Center. All CAL projects are characterized by using data-driven analysis and diverse stakeholder engagement to develop effective recommendations.

**Curriculum for the Triangle Bioregion**

Duke has initiated a program called the Curriculum for the Triangle Bioregion (C4TB), where all academic institutions in the three-county area, which also geographically share the Piedmont Bioregion (EPA Ecoregion 3), work together to share and produce place-centered curricula and activities to anchor student learning in the geography and culture where they eat, work, and play. An inaugural workshop was held in September 2017, which engaged 19 attendees from 4 institutions from the Triangle.

**Education Recommendations**

With these current and ongoing initiatives, Duke has offered more than 2,000 courses from nearly 50 departments that are related to sustainability. In May 2018, 36% of students graduated from a program with sustainability-related learning outcomes. With the goal of having each student develop a working knowledge of sustainability, the following strategies and recommendations have been made.

**Strategy 1: Provide opportunities to further connect all students’ academic pathways to sustainability**

- Expand the reach of the sustainability certificate program to new disciplines and engage new faculty in teaching courses within the certificate parameters
- Pilot a “Sustainability Expeditions” program with the goal of putting concepts of sustainability into courses across disciplines, which is similar to existing Data Expeditions and Archival Expeditions programs.
  - [Data Expeditions](#) - large datasets are used to introduce exploratory data analysis to students that solidify lessons learned in the classroom.
  - [Archival Expeditions](#) - library archival materials related to particular coursework serve as a cornerstone of undergraduate learning materials
- Continue connections with Duke’s Offices of Civic Engagement and Service Learning to expand opportunities to integrate sustainability into these efforts.
- Explore opportunities to integrate sustainability concepts into Duke’s “first touch” courses in many disciplines as well as a new type of course called “Collaborative Inquiry,” that Duke is exploring that could infuse concepts of sustainability with experiential education
Strategy 2: Identify new opportunities for students and faculty to utilize the campus and surrounding region as a teaching tool

- Develop educational support for students and faculty to encourage the use of Duke University’s campus as a living laboratory.
  - Support could be in the form of website materials and consultation provided by Sustainable Duke, identification of existing sites on campus that could be used for class assignments, and facilitation of relationship building between faculty and students.
- Collaborate with existing university programs that work towards solutions to local issues by engaging students, staff, and faculty with an interdisciplinary approach, such as Bass Connections.
- Create a committee of current faculty, staff, and students to further incorporate Curriculum for the Triangle Bioregion into existing coursework.

Strategy 3: Expand resources for faculty to integrate the concepts of sustainability into their courses and build institutional knowledge on sustainability-related projects

- Formalize the position of Faculty Director of Sustainability in the University, including development of a formal job description, with a term length, and formal reporting relationship ties to Duke Administration.
- Expand the pilot Trillium Student Research Initiative (TSRI) to additional courses, departments and disciplines. This program enables a graduate student to provide technical assistance to add sustainability learning outcomes into a new course including creation of lesson plans, researching necessary course materials, and developing assignments to gauge critical thinking and collaboration among students.
- Develop a database of sustainability-related projects that have been conducted by students and faculty whether in the classroom, as a part of research, or as an extracurricular activity. This could expand and institutionalize past inventories of faculty research connected to sustainability topics.
Outreach and Communication

Overview

Duke University is dedicated to promoting sustainable behavior changes and education among students, faculty, and staff in ways that directly impact the reduction of greenhouse gas emissions on campus. Over the past decade, Sustainable Duke in partnership with many other departments, including Facilities Management, Parking and Transportation, Duke Dining, Human Resources, News and Communications, and the Nicholas School of the Environment, has elevated the presence of sustainability at Duke University through the robust communication and outreach strategy outline in the 2009 Climate Action Plan. Major highlights include:

- Over 10,000 signatures from students, staff, and faculty for the Duke Sustainability Pledge.
- 200 students have been a part of the Green Devils, a student-based group of Sustainable Duke who have made lasting sustainable impacts on campus since 2006.
- Adoption of the “Green Devil” for Sustainable Duke branding across campus
- Development of a broad-reaching Green Certification program that includes certification for workplaces, labs, classrooms, events, dorms, and Greek life.
- Hosting over 100 sustainability-related workshops that engage students, staff, and faculty.
- Development of campus-wide competitions, such as the Green Devil Smackdown, UnPark Yourself, and the Green Devil X Challenge, which have motivated behavior change and educated the Duke community about sustainability.
- Feature sustainability efforts in each issue of the Working@Duke magazine that is distributed to all employees.
- Development and distribution of an annual Sustainability Strategic Plan to provide an update on Duke’s progress towards its goals.

2018 CAP Education and Outreach Recommendations

Building on the successes of the past decade, it is now time to develop even more far-reaching communications efforts to engage the Duke community and further reduce campus emissions towards the climate neutrality target. The strategies outlined below are recommendations from the Communications subcommittee of the Campus Sustainability Committee.

Objective 1 - Develop a robust network of Sustainability Champions in all workplaces, classrooms, labs, and dorms

Duke University has a strong network of students, staff, and faculty who are interested and engaged with sustainability on campus. These members of the Duke community have helped increase the sustainability of campus through their work in their departments, labs, and dorms. It is time to build on this momentum by developing relationships with individuals who are
interested in sustainability at Duke, but are not yet engaged. To meet the objective outlines above, the following recommendations have been made.

- Host department-specific sustainability workshops.
- Develop a formal network of Sustainability Champions, who serve as both advocates and ambassadors of sustainability at Duke.
- Gather stories from Sustainability Champions about their experiences and share them with the Duke community.
- Host annual recognition ceremony for students, staff, and faculty Sustainability Champions.
- Provide a monthly sustainability challenge to Sustainability Champions and newsletter recipients.

**Objective 2 - Foster a broad-reaching culture of sustainability for all students, staff, and faculty**

Duke University is home to more than 35,800 students, staff, and faculty (excluding Health System). Each of these people are decision makers in the sustainability of their daily life whether it is energy use on campus, personal dietary choices, and commuting habits. While it is difficult to reach every single one of these people, it is important to find ways to engage them where they live, learn, and work. Below are some recommendations to broaden current sustainability impact by reaching out to established organizations and events.

- Increase the level of engagement by Sustainable Duke during student and employee orientation events.
- Develop departmental and school specific climate action plans.
- Continue to bolster the Green Certification program for departments, classrooms, dormitories, labs, and events.
- Integrate sustainability planning into existing Duke groups like Duke Student Government, Graduate and Professional Student Council, First-Year Advisory Council, and Resident Assistants.

**Objective 3 - Expand Duke’s sustainability impact beyond campus boundaries**

Over the past decade, Duke has built strong relationships with students, staff, and faculty on campus. However, with the transient nature of our community, mainly the student population, it can be difficult to maintain institutional knowledge on sustainability and capture the impact of student work beyond graduation. Therefore it is important to build lasting connections through Duke’s alumni network. It is also beneficial to collaborate with peer institutions to amplify the sustainability efforts of higher education. Below are some recommendations to develop new and long-term relationships.

- Build relationships with Duke alumni who were involved with sustainability so they can easily connect with Sustainable Duke and current students.
- Develop an alumni-focused newsletter that shares information on sustainability at Duke.
- Share best practices and lessons learned with peer universities through conferences, sustainability consortiums, and existing email lists.
Conclusion and Next Steps

After reviewing all aspects of the 2009 CAP, assessing future needs of the campus and working with the Campus Sustainability Committee to develop new recommendations, Duke University has developed new projections for meeting the 2024 goal of carbon neutrality. If all elements of the 2018 CAP are implemented as recommended, the University would be at an estimated 84% reduction of total greenhouse gas emissions by 2024, with approximately 55,000 MTCO2e left to offset.

The emission reductions modeled in Figure 18 below are ordered based on the University’s ability to implement and control. While Duke fully intends to pursue off-site solar and biogas, there are external factors that will impact the timing, cost and procurement options. It should be noted that the biogas purchase modeled in the projections is based on the amount necessary to offset natural gas used in campus steam plants. Replacing approximately 10% of the fuel used in the campus steam plants, would make them carbon neutral. Neutrality results from a combination of the capture and destruction of the biogas that would have been emitted into the atmosphere plus the displacement of conventional natural gas that would have been used to fuel the steam plant. If Duke made a larger biogas purchase it could potentially make the entire campus carbon neutral or even “carbon positive,” as the University would reduce more carbon in the atmosphere than it releases. However, Duke will continue to focus on reducing on-campus emissions and developing a diversified portfolio of carbon offset projects to minimize risk and ensure the campus continues to meet its carbon neutrality goal into the future.

Figure 18: Duke University updated potential emission reductions through 2024

After review from the Campus Sustainability Committee, this 2018 CAP update has been made publicly available for a 45-day comment period. University staff plan to share this information through campus events, targeted meetings with internal and external stakeholders and a comment portal on the Sustainable Duke webpage. All comments will be reviewed, publicly addressed and incorporated where appropriate in early 2019 prior to finalizing the Climate Action Plan update spring semester 2019.
Appendix 1: Sustainability Progress Timeline

Below is a timeline of sustainability at Duke University based on the categories included in Duke’s annual Sustainability Strategic Plan Progress Report. Please note that this list is not exhaustive of all sustainability progress at Duke University.

Campus Sustainability Planning

- 2004 - Sustainable Duke was created.
- 2005 - Duke Environmental Policy was created.
- 2007 - Duke University signed the American College and University Presidents’ Climate Commitment and formed a Presidential-level Campus Sustainability Committee.
- 2009 - Duke’s first Climate Action Plan was published.
- 2011 - Duke begins development of a Sustainability Strategic Plan to integrate the following topics into University strategic planning on an annual basis:
  - Water
  - Waste
  - Food
  - Natural Resources
  - Sustainable investment
  - Procurement

Carbon Offsets

- 2009 - The Duke Carbon Offsets Initiative was established.
- 2011 - The Duke Carbon Offsets Initiative partnered with Google, Inc. and Duke Energy created the Loyd Ray Farms swine waste-to-energy project in Yadkinville, NC.
- 2013 - The Loyd Ray Farms swine waste-to-energy project generated its first verified carbon offsets.
- 2013 - The DCOI has partnered with South Carolina’s Help My House program energy efficiency program to purchase carbon offsets.
- 2014 - The DCOI developed a draft urban forestry-based carbon offset protocol to encourage the planting and maintenance of trees in urban settings.
- 2016 - The DCOI partnered with Second Nature to develop guidance on carbon offset project development and management that can be used by peer universities.
- 2016 - The DCOI convened an academic & professional committee to develop Peer Verification as an alternative to 3rd party accredited verification for offset project review.
- 2017 - The DCOI partnered with Oberlin College and University of Florida to develop a web-based carbon offset project database called the Offset Network.
- 2017 - The DCOI urban forestry partnerships has led to the planting of over 6,000 trees around the United States over the past year.
- 2017 - The DCOI developed an educational workshop that is designed to educate employees about home energy efficiency.
• 2017 - The DCOI led a peer verification training to enable schools to verify each other’s offset projects as academic opportunities, hosted by Arizona State University.
• 2018 - The DCOI partners with Delta Airlines to offset Duke’s 2017 air-travel emissions and plant 1,000 trees in Durham targeting historically redlined neighborhoods.
• 2018 - The DCOI completes peer validation through Offsetnetwork.org, with American and Elon students evaluating the success of Duke’s urban forest plantings in NC.

Infrastructure
• Energy
  o 2010 - East Campus Steam Plant is re-commissioned as a high efficiency natural gas plant.
  o 2011 - West Campus Steam Plant began conversion to a high-efficiency natural gas plant and Duke University ended the use of coal in on-campus steam plants.
  o 2011 - Solar thermal system is installed on the Bryan Center providing 40% of the building’s hot water needs.
  o 2013 - Duke developed a strategic plan to convert campus steam distribution to a more efficient hot water distribution system.
  o 2013 - Duke installed a condensing economizer at the West Campus Steam Plant, which increased the efficiency of the plant by 5-7%.
  o 2014 – Duke implemented energy efficiency measures in the School of Medicine, which is estimated to produce $2 million in savings in fiscal year 2014.
  o 2017 - Duke finalized the planning stages for a large-scale LED lighting retrofit project that is estimated to greatly reduce lighting energy used in 1.3 million square feet of campus buildings.
• Buildings
  o 2012 - Duke has 25 LEED certified buildings and 10 registered buildings.
  o 2014 - Duke finalized a green building guideline that focuses on energy and water efficiency.
  o 2014 - Duke has 29 LEED certified buildings and 9 registered buildings.
  o 2015 - Duke has 30 LEED certified buildings and 9 registered buildings.
  o 2015 - Duke University’s Board of Trustees approved the updated Sustainable Building Policy.
  o 2016 - Duke has 41 LEED certified buildings and 4 registered buildings.
  o 2016 - Duke established a University Green Building Energy Consumption Standard to ensure new building projects prioritize utility efficiency.
• Water
  o 2010 - Duke University added cisterns and wells for Chiller Plant 2, which provide 40 million gallons of non-potable water annually.
  o 2013 - Duke implemented water-reduction measures for the 6 highest water-consuming University buildings.
  o 2013 - Construction began on the Water Reclamation Pond.
  o 2014 - Water efficiency retrofits have been completed in 15 campus buildings, which are estimated to save 15 million gallons of water per year.
2015 - The Water Reclamation Pond was completed and saved 90 million gallons of water in the first year of operation.
2016 - Duke completed the third phase of a multiyear water audit, which led to the installation of low-flow plumbing hardware in the top 30 water consuming buildings.

- Land Use and Natural Resources
  - 2010 - Construction began on Phase 4 of the Stream and Wetland Assessment Management Park (SWAMP) site.
  - 2013 - Duke adopted a campus wood policy to preserve Duke’s trees on campus.
  - 2015 - Duke developed a draft framework for evaluating campus natural landscapes on their ecological, programmatic, cultural, pedagogical, and aesthetic value.
  - 2015 - Duke formally recognized the importance of Anderson Woods and Chapel Woods based on their educational, conservation-based, and aesthetic value.

Campus Operations
- Transportation
  - 2007 - Duke Bikes was launched.
  - 2010 - Replaced 10 campus buses with two hybrid, articulated buses and 6 ultra-low-sulphur diesel buses.
  - 2012 - More than 1,300 students and employees have signed up for Duke’s WeCar program.
  - 2012 - More than 7,000 students and employees have signed up to be GoPass card holders, which allows them to use regional public transportation for free.
  - 2013 - Duke hired its first transportation demand manager to develop alternative transportation strategies for student and employee commuters.
  - 2014 - Duke developed transportation reports for individual schools to provide targeted outreach and promotion of sustainable transportation options at Duke.
  - 2014 - Duke hired a transportation demand management outreach coordinator.
  - 2017 - Duke developed a Bicycle and Pedestrian Plan, which lists recommendations to improve the university’s alternative commuting opportunities.
  - 2017 - Duke has installed 14 new electric vehicle charging stations, bringing the total to 19 charging stations.

- Food and Dining
  - 2011 - The Duke Campus Farm was established, which is a 1-acre food production and educational farm.
  - 2011 - The Duke Campus Farm produced 6,400 pounds of produce in first year of operation
  - 2012 - Composting food waste is incorporated for all campus eateries.
  - 2013 - The Duke Campus Farm had over 1,300 volunteer hours and production increased by 40%.
2014 – Duke developed broad guidelines for best practices in setting and maintaining sustainable sourcing goals in dining services.


2017 - Duke hired its first Sustainability and Quality Control Manager for Duke Dining.

2017 - The Duke Campus Farm grew more than 13,000 pounds and 40 varieties of produce for campus dining facilities and DCF’s Community Supported Agriculture (CSA) members.

**Waste and Recycling**

2007 - Duke’s first-year picnic became a waste free event.

2010 - Duke University’s Free Store expanded efforts to provide donated office supplies to other offices at no charge.

2012 - Duke services 1,600 recycling bins around campus.

2013 - An audit of Duke’s waste streams was conducted.

2013 - Recycling rate for Duke University was 30%.

2014 - Recycling rate for Duke University was 37%.


2016 - Through waste-free football efforts, Duke Football had the first waste-free ACC game, which diverted 93% of waste collected at the game and during tailgating.

**Procurement**

2005 - Duke established a partnership with Staples Advantage to identify and label “Green” office products.

2012 - Duke Surplus donated more than 10,000 items and recycled more than 350,000 pounds of electronic waste.

2014 - Sustainable Duke in partnership with Duke Student Government passed a resolution to limit the amount of free printing for students resulting in a 24% reduction in undergraduate printing.

2017 - Duke Procurement partnered with the Office of Institutional Equity to develop training and tools to educate the Duke community to identify and use local women-owned, minority-owned, and veteran-owned businesses.

2017 - Duke Surplus has diverted over 60,000 items from the landfill through donations to local businesses since 2013.

**Education and Engagement**

**Education**

2010 - Duke establishes the Trillium Project, a faculty learning community dedicated to increasing the prevalence and quality of sustainability concepts in academic courses.

2010 - Sustainable Duke began publishing a list of academic courses that incorporate environmental, economic, and social aspects of sustainability.

2012 - Duke created the position of Faculty Director of Sustainability.
- 2012 - The Duke Green Classroom Certification program was created.
- 2013 - The Theory and Practice of Sustainability (ENVIRON 245) was created, which is the gateway course for students in the undergraduate Sustainability Engagement Certificate.
- 2013 - 35% of Duke graduates earned degrees in programs with sustainability learning outcomes.
- 2013 - 9 master’s projects from the Nicholas School of the Environment were focused on campus sustainability issues.
- 2013 - The Trillium program has trained 52 fellows since inception.
- 2013 - 35% of Duke graduates earned degrees in programs with sustainability learning outcomes.
- 2013 - 9 master’s projects from the Nicholas School of the Environment were focused on campus sustainability issues.
- 2013 - The Trillium program has trained 52 fellows since inception.
- 2014 - Duke initiated a pilot of an international Sustainability Literacy Test on campus to assess changes in undergraduate sustainability literacy.
- 2016 - Duke approved the new undergraduate experiential certificate in Sustainability Engagement.
- 2016 - The Trillium program has trained over 115 fellows since inception.
- 2017 - Duke developed the new Curriculum for the Triangle Bioregion initiative, which engages students with concepts of environmental education and sustainability in the context of Duke’s local community.
- 2018 - Duke launches a pilot Trillium Sustainability Fellowship program, which pairs an undergraduate researcher with a faculty member to integrate sustainability into academic curricula.

- Communications
  - 2011 - The Duke Green Workplace Certification was created.
  - 2012 - The Green Devil Smackdown competition was created and brought together 63 teams of students, staff, and faculty to compete in a variety of sustainability challenges and quizzes.
  - 2013 - Sustainable Duke’s workshop through Learning and Organizational Development has educated 263 employees since inception.
  - 2014 - The Battle of the Schools sustainability competition resulted in a 390% increase in the number of green certified laboratories.
  - 2015 - The Duke Carbon Offsets Initiative piloted a program for Duke employees to install residential solar at a discount leading to the installation of over 150 kilowatts of solar capacity around the Triangle.
  - 2016 - Since the inception of the Green Certifications program, over 10,000 Duke students, staff, and faculty have participated in the certifications.
  - 2017 - The Leading for Sustainability trainings have reached 11 different departments and over 200 staff in 2 years.
Appendix 2: Campus Sustainability Committee Members

The Duke University Campus Sustainability Committee (CSC), a standing committee appointed by the President, is responsible for making recommendations to guide campus sustainability policies, championing these sustainability initiatives, and communicating them to each member’s respective constituencies to foster a more sustainable campus community. Below is the 2018/19 membership.

<table>
<thead>
<tr>
<th>Faculty</th>
<th>Term Ends</th>
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<tbody>
<tr>
<td>Toddi Steelman (Co-Chair)</td>
<td>2020</td>
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<tr>
<td>Fred Boadu</td>
<td>2019</td>
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<tr>
<td>Charlotte Clark</td>
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<td>Ellen Davis</td>
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<td>Lee Ferguson</td>
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<td>Rick Larrick</td>
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<td>Dirk Philipsen</td>
<td>2020</td>
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<td>Tim Profeta</td>
<td>2020</td>
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<td>Valerie Sabol</td>
<td>2019</td>
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<tr>
<td>Rebecca Stein</td>
<td>2020</td>
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<td>Jonathan Wiener</td>
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<tr>
<td>Tallman Trask (Co-Chair)</td>
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<td>Matthew Arsenault</td>
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<td>Tavey Capps</td>
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<td>Carl DePinto</td>
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<td>Jason Elliott</td>
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<td>Joe Gonzalez</td>
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<td>Mark Hough</td>
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<td>Anne Light</td>
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<td>Leonora Minai</td>
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<td>John Noonan</td>
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<td>Jane Pleasants</td>
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<th>Students</th>
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<tr>
<td>Divya Dayanidhi</td>
<td>2019</td>
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<tr>
<td>Tara Early (President)</td>
<td>2019</td>
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<tr>
<td>Robert Harris</td>
<td>2019</td>
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<tr>
<td>Caroline Heitmann</td>
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<td>Thomas Hessel</td>
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<td>Layne Marshall</td>
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<td>Olivia McKinney</td>
<td>2019</td>
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<tr>
<td>Emily Millar</td>
<td>2019</td>
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<tr>
<td>Cameron Oglesby (President)</td>
<td>2019</td>
</tr>
<tr>
<td>Amanda Ullman</td>
<td>2019</td>
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