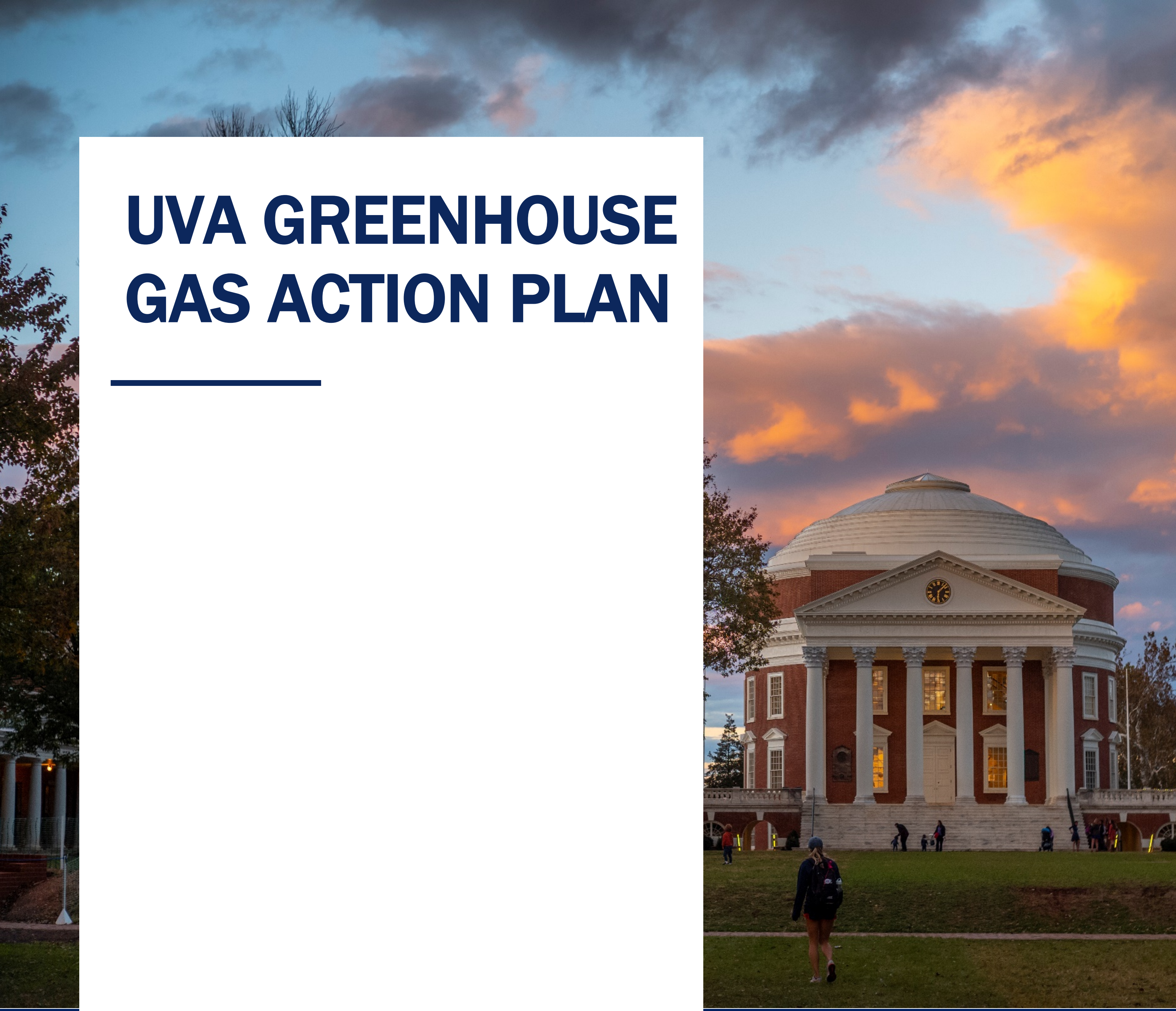

UVA GREENHOUSE GAS ACTION PLAN

UPDATED MAY 2019

UVA SUSTAINABILITY
Authored by: Energy Strategy Task Force
Compiled by: Andrew Pettit, Office for Sustainability

SUSTAINABILITY · UVA
From the Grounds Up

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Executive Summary

The University of Virginia (UVA) is committed to reducing greenhouse gas (GHG) emissions and energy use across its Grounds. In 2011, UVA's Board of Visitors (BOV) passed a resolution to reduce University-wide GHG emissions 25 percent below 2009 levels by 2025. In 2013, UVA's BOV approved a goal to similarly reduce UVA's nitrogen footprint, and UVA signed on to the Department of Energy's Better Buildings Challenge, which established a goal to reduce building energy use intensity (EUI) 20 percent below 2010 levels by 2020. In 2016, UVA launched its first Sustainability Plan with long-term goals and actions through 2020.

UVA's GHG Action Plan seeks to bring alignment and clarity to UVA staff, faculty, students, and alumni actively and collaboratively implementing strategies within the plan. Additionally, this Action Plan aims to provide the UVA community and its partners with a transparent roadmap of specific strategies for how UVA will meet its GHG emission reduction goal, currently projected to require a reduction of approximately 120,000 Metric Tons of Carbon Dioxide Equivalent (MTCDE). This Action Plan will continue to be updated as needed, to incorporate new and innovative ideas and technologies. The most recent UVA GHG Annual Report explains UVA's GHG emission calculation methodologies, documents the current footprint, and provides a detailed analysis of the inventory. The strategies and their projected impacts outlined in this Action Plan represent potential opportunities to reduce GHG emissions across the various sectors of UVA, as illustrated in Figure 1 and described in Table 1.

Figure 1: UVA GHG Emissions by source (MTCDE), 2009-2018

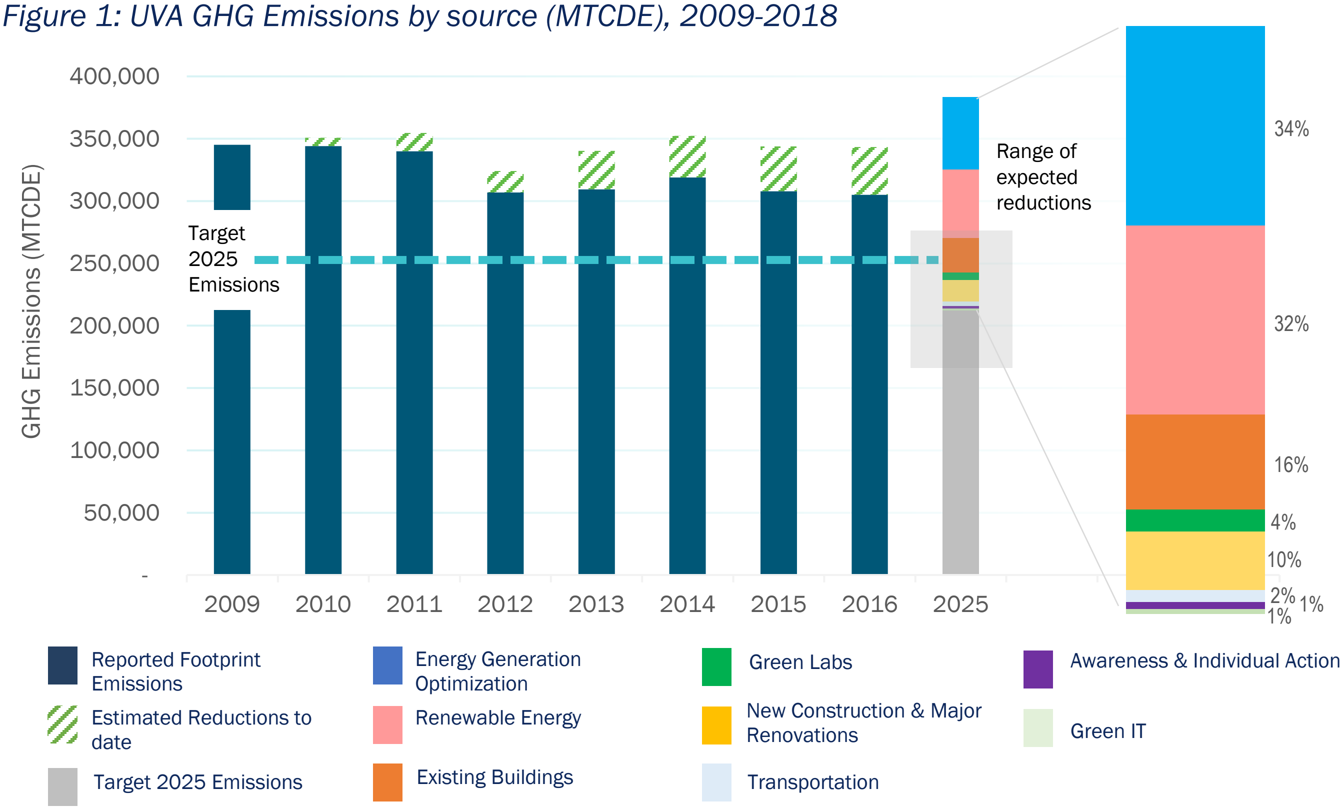


Table 1: Summary of GHG Reduction Strategies

Sector	Strategies	Total	
		Low	High
Energy Generation Optimization (On-Grounds): The majority of UVA's thermal energy is generated from UVA-owned district energy plants by burning natural gas and coal. It is then distributed through extensive underground networks of steam, medium-temperature heating water, low-temperature heating water, and chilled water piping.	Fuel Optimization	12,000	14,000
	Chilled Water Plant Energy Efficiency Improvements	4,000	5,000
	Heat Plant Efficiency Improvements	2,000	3,000
	Distribution Efficiency	5,000	6,000
	Alternative Energy Technologies	25,000	30,000/TBD
	Dominion-Electricity Grid Improvements	2,000	8,000
	Total:	**50,000**	**66,000**
Renewable Energy (Energy Generation): Harnessing reliable renewable energy and decreasing reliance on fossil-fueled generated electricity are major priorities for UVA.	On-Grounds	1,000	2,000
	Off-Grounds	16,000	18,000
	Additional Utility Scale	13,000	60,000+
	Total:	**30,000**	**80,000**
Existing Buildings: UVA has over 550 buildings widely ranging in age, size, and primary use. These facilities serve an array of functions including academic and medical research, education, patient care, housing, and office space.	Building Specific Energy Improvements	25,000 – 30,000 projected reductions for existing buildings aggregate implementation strategies outlined in this Action Plan.	
	Systematic Water Technology Rollout		
	Controls		
	Enhanced Maintenance Refinement & Training		
	Operations & Maintenance Staff Sustainability Engagement		
	Total:	**25,000**	**30,000**
Green Labs: Laboratories across Academic and Health Systems areas require intensive energy infrastructure to maintain state of the art equipment and manage the handling of hazardous chemicals and biological agents.	Equipment Improvements	1,000	2,000
	Infrastructure Modifications	4,000	6,000
	Total:	**5,000**	**8,000**
New Construction & Major Renovations: These projects offer an opportunity for UVA to reduce building energy usage and therefore the overall energy usage per square foot for all of the buildings.	Green Building Standards for Energy	7,000	10,000
	Deep Energy Reductions	7,000	10,000
	Total:	**14,000**	**20,000**
Transportation: With over 40,000 commuters and daily operations requiring transportation, UVA has several opportunities to improve efficiencies in this sector. However, growth remains a challenge and could potentially offset any reductions.	Commuting	0	5,000
	Buses	0	1,000
	Fleet Vehicles	0	1,000
	Total:	**0**	**7,000**

Awareness and Individual Action: UVA's Sustainability Plan includes a goal to increase sustainability awareness and outlines programs that translate awareness into measurable energy savings.	Occupant Energy & Sustainability Engagement	1,000	3,000
	Total:	**1,000**	**3,000**
Green IT: The diffuse operation and management of IT equipment creates a unique challenge for assessing and understanding the extent of UVA's energy and GHG footprint and the opportunity for improving efficiency.	Green IT	1,000	2,000
	Total:	**1,000**	**2,000**
Offsets: UVA recognizes there may be a need to offset emissions as a GHG reduction strategy but will not prioritize financial resources to purchase offsets.			
	Total:	**126,000**	**216,000***
	Estimated reductions needed by 2025	**110,000**	**130,000**
		(Assuming 121,662 MTCDE)	

**These GHG emission reduction estimates were calculated using conservative assumptions and will most likely increase as more accurate data is collected.*

Introduction

Purpose

The primary purpose of UVA's Greenhouse Gas (GHG) Action Plan is to bring alignment and clarity to UVA staff, faculty, students, and alumni actively and collaboratively implementing strategies within the plan. The GHG Action Plan also aims to provide the UVA community and its partners with a transparent roadmap of specific strategies for how the University plans to meet its GHG reduction goals. The document will continue to be updated as needed, to incorporate new and innovative ideas and technologies.

This GHG Action Plan was developed by the Energy and Emissions Task Force, facilitated by the Office for Sustainability (OFS) and comprised of individuals across several disciplines in Facilities Management, Parking and Transportation, the Green IT Working Group, and the Offsets Task Force. This plan refines and updates the 2009 Environmental Footprint Reduction Plan, including revising projections for how growth at UVA impacts the GHG reduction required to achieve the goal, as well as projections for anticipated GHG reductions generated by implementation of the strategies described herein, currently estimated to range from 126,000 – 216,000 MTCDE.

Goal setting

In 2011, the University of Virginia committed to reduce University-wide GHG emissions 25 percent, or approximately 85,000 metric tons of carbon dioxide equivalent (MTCDE), below 2009 levels by 2025. The commitment included emissions generated from University growth, which were estimated at that time to be 47,000 MTCDE through 2025. As of 2016, UVA has reduced its emissions 40,000 MTCDE, or 11 percent, below the 2009 levels while offsetting emissions associated with new facilities added since 2009.

Revised growth projections indicate that new and renovated buildings in construction or planned between 2015 and 2025 will significantly increase UVA's challenge to reach its goal. As such, UVA now needs to eliminate an estimated 110,000 to 130,000 MTCDE from its GHG footprint between 2016 and 2025, **in addition to the reductions already achieved,** to meet the original 25 percent reduction goal. Although, these projections are likely to change as capital project plans evolve in the future, the strategies in this document were developed with the 110,000 to 130,000 MTCDE challenge in mind. These goals encompass all of the 16 million square feet of buildings at the University including the University Hospital and Clinics.

Progress to date

To track the University's progress towards its GHG commitment, UVA's Office for Sustainability calculates and analyzes the annual GHG Inventory. UVA's Annual GHG Report explains the GHG emission calculation methodologies, documents the current footprint, and provides a detailed analysis of the data to target potential areas for further reductions to help meet the 2025 goal.

Since 2009, there has been a population increase of 3,194 full-time equivalent students, faculty, and staff (an 8.8 percent increase). To support this growth, 48 facilities have been constructed or acquired since 2009, resulting in an increase of approximately 2.4 million square feet (a 16.2 percent increase) included within the GHG inventory's boundaries. The University's commitment to achieving this goal considering the continuing expansion is driving heavy investments in expanding sustainability efforts to enhance the University's operations and building portfolio.

In 2016, UVA launched its first Sustainability Plan and outlined both long-term goals and short-term actions through 2020. Included in the Sustainability Plan is a commitment to significantly reduce the use of coal on-Grounds and to increase the percentage of UVA's energy derived from renewables, two activities that will greatly improve UVA's ability to meet its GHG goal.

On-Grounds energy generation

UVA generates most of its heating and cooling energy in district energy plants, then distributes that energy to facilities through an extensive underground network of steam, medium-temperature hot water (MTHW), low-temperature hot water (LTHW), and chilled water piping. Centralized energy generation presents many opportunities to reduce energy and water use and GHG emissions.

Fuel optimization

The UVA Main Heat Plant uses coal, natural gas, and distillate fuel oil to generate steam and hot water to heat many of its facilities. With the adoption of the GHG reduction goal in 2011, a plan was established to move from a coal-dominant fuel mix to a natural gas-dominant mix, due to natural gas' lower GHG intensity compared to coal. In addition, natural gas prices became more competitive and are projected to stay affordable in the long term. In 2012, the Main Heating Plant achieved a 58 percent natural gas utilization rate and now consistently achieves a utilization rate between 70 to 75 percent, the maximum it can achieve. UVA is currently working to understand additional opportunities to eliminate coal.

Chilled Water Plants efficiency improvements

UVA chiller plants generate 42°F water, which is used to provide air conditioning in its facilities. The chiller plants consume more than 20 percent of the purchased electricity and 25 percent of the water at UVA, it is a primary target for efficiency initiatives and GHG reduction strategies.

Reduction strategies

Equipment renewal: Replacing older inefficient chillers and controls with new variable speed chillers and state-of-the-art controls immediately improves efficiency.

Standardizing controls: Developing and maintaining consistent operations allows for continuous process optimization and increased efficiency.

Automatic tube cleaning: On-line condenser cleaning allows continuous cleaning of the heat transfer surfaces within a chiller providing more efficient heat transfer.

Cooling tower reset schedules: Developing and testing aggressive cooling tower reset schedules to maximize chiller performance during cooler temperatures.

New approaches to plant operation: By connecting several chilled water loops and generation plants, UVA has been able to reduce operating energy consumption and cost by staging machines that are more efficient on-Grounds during part-load conditions.

Develop an engineered reset schedule for chilled water to supply the optimal temperature and pressures for buildings to meet load whereby reducing thermal losses in the distribution system.

Heat Plant efficiency improvements

Driving the thermal efficiency of the Main Heating Plant from the 80-82 percent range to 83-85 percent is an integral element of the work of heat plant operating staff. Engaging the entire engineering, operations, and maintenance staff will be critical to achieving this goal. To ensure that thermal efficiency does not decline as more natural gas is used, boiler controls, configuration, maintenance, and operation will need to be adjusted. Several of the projects and programs that have been identified to improve thermal efficiency include:

Reduction strategies

Utilize data acquired by the extensive automation systems to pinpoint inefficiencies identified through comparative analyses between the boilers and optimized set points.

Increase economizer capacity to reclaim heat from flue gases that are otherwise lost.

Install variable frequency drives (VFDs) to modulate draft fan speed by reducing power consumption instead of current draft dampers employed on constant speed fans.

Provide a modulating compressed air system to meet demand with right-sized equipment.

Develop an engineered reset schedule for MTHW to supply optimal temperature and pressures so buildings can meet load while reducing thermal losses.

Optimize the smaller boiler loop served by the Massie Road Plant by eliminating the building converters and connecting the plant directly to the building loops. This will result in the ability to significantly reduce the heating hot water supply and return temperature from 230°F to 180°F or below, consequently reducing boiler fuel consumption.

Between 2017 and 2019, a focus will be placed on optimizing UVA’s plants. Work beyond 2019 will focus on maintaining efficiency gains and implementing other strategies for the district energy systems on-Grounds

Distribution efficiency

UVA operates an existing district heating system centered on the Main Heating Plant, which produces saturated steam and MTHW for campus heating and other uses. LTHW generation and distribution systems can be more efficient than steam systems and even MTHW because energy generation is much more efficient at lower temperatures plus less heat is lost in distribution between the points of generation and consumption. Furthermore, LTHW systems can to take advantage of more efficient technologies such as waste heat recapture that then reduces electrical and water consumption.

Reduction strategies

Shifting a significant portion of UVA's heat energy consumption from Steam/MTHW to LTHW distribution: The Main Heat Plant generates steam and MTHW and distributes them to buildings through extensive networks of pipes. At most buildings, steam or MTHW is then converted via local heat exchangers back to LTHW or domestic hot water. A more energy efficient and cost-effective system would be a direct LTHW distribution service, but LTHW is not easily piped long distances. A fitting solution could be a system with "hubs" across Grounds that would convert steam or MTHW to LTHW and distribute it to all buildings in a specific zone. In most cases, the existing thermal distribution system components could be reused, minimizing the cost of transitioning to a new system. This would also allow UVA to strategically convert to LTHW in smaller, less disruptive phases.

Alternative energy technologies

Several large-scale alternative energy technologies are being explored. One technology, cogeneration, also known as combined heat and power (CHP), is a system in which heat produced as a byproduct of electricity generation is recovered and used to create steam and hot water for heating. CHP is effective in reducing fossil fuel use and GHG emissions as it doubles the useful energy output of traditional generation used by electrical utility companies.

Depending on how CHP is integrated into the distribution infrastructure, the system could provide resiliency to UVA's power supply for critical buildings during grid emergencies or widespread power outage. The ongoing engineering and financial analysis of CHP options and impacts will guide the path forward for this technology at UVA.

Other technologies being considered include hybrid energy plants. A hybrid energy plant is able to generate chilled water and heating water simultaneously using heat recovery chillers. In this type of plant, the heat generated by cooling equipment is transferred into the heating hot water supplied to the buildings. At UVA, the North Grounds Mechanical Plant is an example of a hybrid energy plant in operation. This plant, converted in 2014 and 2015, demonstrated in its first year that a hybrid approach can reduce energy use by almost 50 percent and water use by 10 percent over the traditional district energy plant approach. As such, hybrid energy plants (chillers, condensing boilers, heat recovery chillers, connected to buildings designed or adapted for low temperature hot water) are now the design standard when new precincts are developed, and district energy systems are justified.

Dominion electricity grid improvements

Apart from some rooftop solar systems, UVA purchases all its electricity from Dominion Virginia Power. Although the electricity is not generated on-Grounds, it is included in UVA's GHG inventory because it is used in UVA buildings. Emissions from purchased electricity are calculated by multiplying electricity consumption by an emissions factor, provided by the Environmental Protection Agency's (EPA) Emissions & Generation Resource Integrated Database (eGRID).

Emission factors for purchased electricity consider the fossil fuels used to generate the electricity. For example, if Dominion Virginia Power uses 100 percent coal to generate electricity, the emissions factor would be greater than if Dominion used 50 percent coal and 50 percent renewable energy. Therefore, any change in Dominion's electric grid fuel mix would affect UVA's GHG footprint. Unlike electricity *consumption*, however, UVA does not have direct control over the fuel mix used to generate electricity at Dominion, so the short and long-term effects on UVA's calculated emissions are uncertain. While emission factors for purchased electricity in this area of the country have remained relatively stable since 2010, it is anticipated that Dominion will decrease their use of coal in electricity generation and increase their renewable energy or use of natural gas between 2017 and 2025. A 1 percent to 5 percent improvement in the emission factor could yield a corresponding 2,000 to 8,000 MTCDE emission reduction for UVA based on its electricity consumption profile.

Renewable energy

On-Grounds

Building mounted solar photovoltaic (PV) systems integrate electricity generation with the roof of a building facing the sun. UVA piloted its first roof-mounted PV system (15 kW-AC) in the construction of Skipwith Hall and quickly expanded in-house development of roof-mounted PV systems to Clemons Library (126 kW-AC). Through a lease agreement with Dominion Virginia Power, roof-mounted PV systems have also been installed on Ruffner Hall and on the Bookstore (364 kW-AC). In addition to PV systems, roof-mounted solar thermal systems are a possibility to help UVA harness energy from the sun's radiation to heat.

UVA is working with consultants to develop and identify optimal locations and funding mechanisms for additional building-mounted PV and solar thermal projects on Grounds. This on-Grounds rooftop solar plan will establish a roadmap and framework to deploy solar across UVA. The current Action Plan estimates approximately **2,000 kW-AC installed by 2025**.

Off-Grounds utility-scale

Reduction strategies

UVA Hollyfield Solar: UVA and its Darden School of Business have entered into a solar power partnership with Dominion Virginia Power. Under the agreement, announced in December 2016, the University and Darden will finance the project and purchase the entire output of electricity produced at a new, 160-acre solar facility in King William County for the next 25 years. The UVA Hollyfield Solar project, owned by Dominion, who will construct and operate it, is expected to produce an estimated 17 megawatts of alternating current (AC) power, a figure representing about 10 percent of the University's electrical demand. The Darden School, as a participant in the partnership, will assume responsibility for about 25 percent of the electricity production, which will enable Darden to achieve carbon neutrality. This Action Plan estimates the emissions reductions from the Hollyfield site between 16,000 and 18,000 MTCDE.

Future Utility-Scale Solar: UVA continues to explore other utility-scale solar opportunities and seeks to add another utility-scale renewable project in the future. UVA will also actively pursue additional installations and will move forward as funding allows.

Existing buildings

UVA owns approximately 550 buildings ranging in age from 210 years old to newly constructed. These buildings span from just a few dozen square feet to over a million square feet and serve an array of functions including academic and medical research, education, patient care, housing, and office space. While many of UVA's buildings present opportunities to improve energy efficiency, the wide range of buildings require various types of interventions and building-specific implementation plans. To successfully achieve energy reductions across the building portfolio, projects will be identified and implemented as building-specific optimization, systematic technology rollouts, or through enhanced preventative maintenance activities. The goal is to assess opportunities at all facilities and implement the most effective energy improvements.

Building-specific efficiency improvements

Building-specific optimization is structured around a cross-functional team investigating an entire building to identify holistic and interactive energy efficiency improvements. This strategy builds upon the success of the University's Delta Force program whereby efficiency projects are implemented through a revolving fund replenished through energy cost savings.

This approach is most appropriate and effective for larger, high-energy consuming facilities due to its time-intensive development process and the cost/energy saving potential of those building. The Delta Force team has already institutionalized the process for developing customized and cross-system solutions and will continue this work on the remaining high energy-consuming buildings. This includes analyzing a building and improving the heating, ventilation, and air-conditioning (HVAC) systems and their controls; lighting systems and their controls; building envelope components; and water systems. The final component of an individual project is ongoing monitoring to ensure the savings persist. This will be accomplished through the deployment of automated fault detection, measurement, and verification activities. Between 2017 and 2023, the Delta Force program will work towards meeting an annual square footage target based on the top energy-consuming buildings.

Figure 2: UVA's Energy Efficiency Process

Health System Physical Plant (HSPP) building efficiency improvements

The UVA Health System contributes approximately 40 percent of UVA's overall GHG footprint. To achieve the desired energy and emissions reductions, the Health System, University, and Facilities Management will need to:

Understand the Health System's unique challenges to implement effective energy efficiency projects: This will include understanding the regulations surrounding infection control, constant occupancy and operation throughout the Medical Center and other patient care areas, and the constant evolution of technologies available for medical research.

Incorporate energy efficiency into equipment replacement and building renovation discussions: Other unique challenges the Health System faces include requirements to replace medical equipment and renovate building spaces more frequently. As part of significant capital and equipment renovations, HSPP, Project Services, and Facilities Planning and Construction have been incorporating energy efficient technologies and controls into planned projects. Leveraging future renovation projects further will be the means by which efficiency improvements become more optimized and more readily implemented within the Health System.

In order to embed energy efficiency and emissions-reducing technologies in the Health System's renovations, an **energy efficiency master plan** will be developed. This energy efficiency master plan will review the infrastructure within the Health System's portfolio and identify individual efficiency projects that can reduce the University's emissions footprint. These projects will be developed with scopes of work outlining the required equipment and interconnections, budgetary estimates for completing the efficiency projects, potential returns on investments, and projected impact on carbon footprint.

Systematic technology rollout

New technologies can make significant improvements over the more traditional products typically implemented throughout UVA. As specific technologies with fast returns on investment are identified, UVA will facilitate their rapid deployment.

Reduction strategies

Lighting: Most lighting at UVA is currently provided by fluorescent technology, often with four-foot T8 lamps. While T8 fluorescent technology has made significant energy efficiency improvements over incandescent bulbs and older fluorescents current LED lighting options will further reduce lighting energy consumption by 40 percent.

Deploying LED technology has already been accomplished as part of building-specific projects. However, UVA is exploring LED retrofit options that will limit the selection of replacement options for buildings. This will allow the University to move through the entire building portfolio and expedite the LED conversion.

Building Envelope Improvements: Drones and mobile building thermographic imagery tools are being used to identify opportunities for improvements in the building envelopes. Opportunities here include improvements to insulation, windows, and reducing thermal bridges. Additionally, UVA will systematically deploy building envelope products (e.g. caulking, weather-stripping, and window film) where needed.

Water Efficiency: Similar to the rollout of LED technology, UVA is exploring methods for deploying low-flow faucet aerators and showerheads to reduce overall water consumption, including domestic hot water.

Controls optimization/replacement

Over 200 facilities on-Grounds have building automation systems (BAS) controlling HVAC equipment. Microprocessor-based BAS allow building operation systems to be programmed to maintain comfortable conditions in an energy efficient manner. Energy efficiency strategies programmed into a BAS typically include time of day scheduling, setback/setup temperature set-points, free cooling with outdoor air when conditions permit, and temperature and fan motor resets based on building needs.

As UVA uses a continuously changing pool of contractors and facilitates a dynamic research and teaching environment, control strategies in buildings have been inconsistently implemented or modified from optimal performance to meet a building user's needs. Additionally, as controller technology continues to advance, many of the original BAS controllers have become antiquated. To work through these challenges, UVA Automation Services will perform systematic reviews of the existing BAS to identify control strategy optimization opportunities, develop consistency in programming logic, and implement optimized sequences throughout the portfolio.

Finally, to maintain energy efficiency improvements made within the BAS, Automation Services will develop Automated Fault Detection and Diagnostic (AFDD) rules and equations to mine historical and real-time building operation data to identify anomalies in system operation. These AFDD rules, developed specifically for equipment and operating strategies, will leverage the capabilities of our automation systems to allow maintenance staff to proactively address less-than-optimal conditions and make necessary corrections. Work on the control's optimization has already begun. Widespread review of existing control deficiencies will begin in early 2017 and will continue for the near future.

Operations and maintenance

A comprehensive preventive maintenance (PM) program can keep mechanical, electrical, and plumbing (MEP) systems from using more resources than needed. UVA's Facilities Management employs over 100 licensed mechanical, electrical, and plumbing maintenance employees responsible for performing PM tasks. To overcome the challenges inherent in maintaining diverse systems in buildings both historic and ultra-modern, it is imperative that our mechanics are trained on a set of standard approaches, which specifically identify and reinforce energy and resource reduction opportunities.

Reduction strategies

Preventive Maintenance Refinement and Training: Through its computerized maintenance management system (CMMS), FM maintains a vast inventory of equipment and system assets, a PM schedule, and planned tasks specific to each building. To achieve our reduction strategies, ongoing refinements of PM schedules and tasks will include specific measures related to energy reduction. Once the performance of a system or asset has been optimized, mechanics will be trained on specific aspects of the equipment PM that relate to energy and water conservation. FM will continue to track the energy and water usage by building in order to provide a reliable method of measuring the success and benchmarking building efficiency across UVA and against industry standards.

Operations and Maintenance (O&M) Staff Sustainability Engagement: In addition to Maintenance personnel, FM's Operations consists of Landscapers, Custodians, Roofers, Elevator Mechanics, and other specialty trades. Opportunities exist to refine normal operations and reduce the University's environmental impact. The **Sustainability Stewards initiative**, an O&M-specific subgroup of the FM Sustainability Council, will consist of identifying key personnel from these groups to serve together as a collaborative think tank. Their main goal will be to identify, test, and refine various ways that O&M teams can perform their current work in a greener way. The members of this group will then report their developments to their own O&M teams and continue to spread the philosophy of identifying a more sustainable way to accomplish their work. This program will mirror other successful approaches at UVA to convey best practices.

Green labs

UVA's research activities and medical testing laboratories require energy intensive infrastructure. There are a multitude of facilities on-Grounds, which house research and medical testing with varying requirements for handling hazardous chemicals and biological agents. Additionally, the laboratories require power-hungry equipment to preserve and support research. The energy reduction approach with UVA's laboratory spaces is right-sizing equipment and infrastructure relative to the need of the Principal Investigator's research.

Equipment improvements and individual action

Electricity consumption in laboratory buildings can be attributed in large part to the amount of equipment needed to conduct research. Many large pieces of equipment, such as ultra-low temperature (ULT) freezers can consume as much electricity as a single-family home. To reduce lab equipment energy consumption UVA will:

Reduction strategies

Develop a freezer management program.

Target inefficient cage washers for replacement.

"Right-size" building level steam, vacuum, and compressed air systems.

Implement a lab equipment-sharing program.

Provide timers and automatic shut off capabilities on some equipment (incubators, water baths, centrifuges, shake tables, hot plates, microscopes and vortex mixers).

Another critical effort will be to communicate and teach best practices for the equipment's use and operation. Through UVA's Green Labs program, the University will continue to raise awareness and train researchers on strategies to minimize the environmental impact of research activities. The Office for Sustainability launched the Green Labs program in 2017 and will continually expand its deployment.

Reduction strategies

The Green Labs program, supported by a full-time staff member and pan-university Green Labs Working Group, engages lab occupants in tangible actions to reduce energy use in labs. Early initiatives include a Green Labs certification program and participation in a national freezer challenge to reduce the environmental impact of cold storage.

Infrastructure modifications

Laboratory buildings consume a disproportionate amount of energy relative to the amount of square footage on-Grounds. With an estimated 40 percent of energy usage in a typical lab building driven by ventilation needs, targeting ventilation system infrastructure can have a significant impact on reducing UVA's GHG emissions. To reduce the amount of energy related to laboratory ventilation, UVA will:

Reduction strategies

Conduct a risk assessment of every laboratory space on-Grounds to determine the appropriate ventilation rate based on actual lab conditions.

Allow for nighttime setback of ventilation air in lab spaces which are lower risk (as determined by the risk assessment), and when appropriate, install occupancy sensing and reacting infrastructure.

Modernize fume hoods to ones that can safely modulate airflow based on sash position and operate at lower airflow settings.

Modernize HVAC systems, where appropriate, to transfer energy contained in the exhaust stream for pre-conditioning incoming ventilation air.

In new buildings and major renovations, **decouple ventilation and space conditioning** by providing dedicated HVAC systems.

Convert existing constant volume systems to variable volume.

New construction & major renovations

UVA continues to expand research activities, medical services, patient visits, academic offerings, and associated support services. To meet this growth, there are extensive and continuous construction projects to build new and renovate existing facilities. The additional space adds to the environmental footprint of UVA while simultaneously presenting opportunities to improve building energy efficiency and sustainability.

Reduction strategies

UVA developed **Green Building Standards (GBS)** under the Facility Design Guidelines that prescribe minimum requirements for all new construction and major renovation projects. The GBS embed requirements for equipment efficiency as well as design guidelines based on best practices for energy efficiency at UVA. The most significant element that will affect the energy efficiency of new and renovated buildings on-Grounds is a requirement to **achieve a minimum 25 percent reduction in energy use intensity (EUI)** as compared to an EUI of a similar usage type building, to be determined by UVA. Projects will also be required to evaluate the feasibility of deeper energy reductions and demonstrate that the project analyzed options through energy modeling and life cycle costing. UVA is currently analyzing the possibility of creating a funding source to incentivize projects to drive as far towards a net-zero energy building as possible. A net-zero energy building, as defined by the Department of Energy, can include a combination of internal load reductions and on-site renewable energy.

The GBS will be used to facilitate an integrated process between various departments at UVA, the design team, and the construction team to ensure energy targets are met in design phase and installed accordingly. The GBS will recommend measurement and verification of the building systems to understand the overall energy consumption and provide a framework to continue operating the building as it was designed.

Beginning in 2018, all new construction and major renovation projects will begin targeting the 25 percent energy reduction, with incentives to drive energy consumption as low as possible.

Transportation

Commuting

UVA has established campaigns and incentives to promote sustainable commuting options for faculty, staff, and students to get to destinations in ways other than single-occupancy vehicles.

Mode-split surveys conducted by Parking and Transportation through the UVA Center for Survey Research have shown that the majority of employees commuting to/from UVA do so in single occupancy vehicles. These survey results have also shown that the vast majority of students live within a close proximity to Grounds and already use sustainable means of transportation to go to and from the University Grounds.

Parking and Transportation will continue to identify and implement alterative commuting options, such as the successful UBike Program or a potential partnership with the Thomas Jefferson Planning District Commission's RideShare program, for UVA commuters through outreach, education, and refinements to existing programs.

Buses

UVA's Transit Service (UTS) provides more than 70,000 hours of service and 2.5 million trips per year. UTS operates eight fixed routes within a six square mile area, covering much of the UVA Grounds and nearby Off-Grounds Housing areas. At peak service times, UTS operates as many as 26-27 buses.

While public transit does provide a more sustainable transportation option, operation of a bus fleet is a source of GHG and other emissions. However, these emissions can be reduced through effective fleet management and operational assessments.

Parking and Transportation has developed a long-range fleet replacement plan that will result in more fuel-efficient buses that are built to adhere to more recent emission regulations issued by the Environmental Protection Agency. UTS is scheduled to receive 7 new buses in 2017 and is on track to receive 10 new buses in 2018. As these buses are put into service, older and less fuel-efficient buses will be retired.

UTS buses are also equipped with various levels of technology that allow Parking and Transportation to evaluate idle times and passenger count trends. These technologies could be used to improve route efficiency, reduce idling, and optimize vehicle miles traveled.

FM fleet vehicles

GHG emissions are generated by Facilities Management's vehicle fleet burning fossil fuels such as gasoline. Some of these vehicles transport people and materials to and from job sites, and other machines use distillate oil (diesel and gasoline) to perform work, like blowing leaves and mowing lawns.

Direct fleet emissions constitute 9 percent of the total MTCDE generated by transportation at the University. There has been a rise of 6 percent in emissions from 2009 through 2015, or 220 MTCDE. This increase is attributable to the increased building portfolio needing support from FM staff.

Reduction strategies

Right-sizing fleet and fleet vehicles: UVA has started assessing the fleet through a LEAN Initiative for Facilities Management. Through this process, UVA has laid groundwork that will result in improved processes, reduced waste, and better use of resources. The end goal is to define a high-value fleet that allows UVA staff to perform their duties efficiently, with the least amount of carbon emissions. To achieve this goal, UVA will clearly **define the specific duties and physical requirements of new vehicles** to be purchased. This enables the fleet managers to right size the replacement vehicle by determining what vehicle best suits the business need. For example, UVA will be able to determine that purchasing a vehicle with a V-6 engine instead of a V-8 engine or use a smaller all-terrain vehicle rather than a full-size truck.

Perform a lifecycle cost analysis of the FM fleet to identify the least efficient vehicles, remove them from service, and replace them with optimally sized vehicles.

Explore and implement software technology to improve fuel efficiency and reduce emissions. Vehicle software controllers that customize and optimize engine calibration, idle speed, shift pattern, and torque management have shown potential fuel savings ranging from 6 percent to 12 percent, depending upon application of vehicle.

Develop a cross-functional Fleet Management Working Group with the Office for Sustainability, Parking and Transportation, and other relevant entities to research alternative fuel technologies to be incorporated into FM's fleet

Awareness and individual action

Occupant energy and sustainability engagement

Outreach and engagement programs aimed at reducing energy use on-Grounds have been in existence for over a decade. The 2016-2020 UVA Sustainability Plan includes a goal to further increase sustainability awareness and outlines educational strategies to expand programs that translate awareness into action. Programs offered through the Office for Sustainability are a core component of achieving these goals. These programs have been developed based on research on effective behavior change strategies and are continually refined to achieve the greatest level of participation and action.

Reduction strategies

Green Workplace Program: Targeting faculty and staff in both Academic and Health System spaces, the Green Workplace Program is currently being undertaken in 22 workplaces across UVA, representing roughly 1,400 participants. The program includes 60 actions workplaces can implement, and the energy section of the checklist recommends changes from temperature settings to consolidating individual appliances. This program is currently UVA's most effective means of developing relationships with staff for continuous energy conservation opportunities. The Sustainability Plan seeks to achieve a **minimum of 50 percent participation** by UVA faculty and staff in sustainability programs by 2020.

Sustainability Advocates (SA) Program: A peer-to peer volunteer program based in UVA residential spaces, the SA program works to enable students to be leaders in sustainable lifestyle practices such as energy conservation. This program is essential in communicating energy conservation efforts undertaken in residential spaces.

Awareness Campaigns: The Office for Sustainability's Outreach & Engagement program has developed multiple energy-related awareness campaigns over the years for the broad UVA community as well as more targeted audiences.

Dorm Energy Race: For the past 8 years, UVA has implemented a residential electricity reduction competition in all first-year residences - the Dorm Energy Race. This program has seen varying levels of electricity savings throughout the 4-week competition held each October. The program relies heavily on peer-to-peer communication and motivation to reduce electricity usage through individual action.

Green IT

Computer use and IT infrastructure are extensive throughout UVA, consuming an estimated 5 percent to 15 percent of all electricity on-Grounds, but the diffuse operation and management of IT equipment creates a challenge for assessing and understanding the GHG footprint. Through the Green IT Working Group, other inter-departmental IT committees and task forces, and the Office for Sustainability, UVA will begin cataloging computing systems across Grounds as a first step toward assessing opportunities for improving efficiency.

Upon the creation of a catalogue of the IT infrastructure, targeted efficiency measures will be identified, discussed, and implemented to reduce energy consumption. The reductions will target:

Reduction strategies

Clients (individual desktop, laptop, tablet computers): procure energy efficient equipment, optimize power settings, deploy active power management utility, right-size the devices for individual's computing needs (provide laptop instead of desktop where appropriate, greater deployment of tablets and other efficient computing devices).

Servers: increase virtualization, consolidate servers distributed in buildings throughout Grounds into data centers with efficient cooling and utility systems, optimize conditioning set points.

Infrastructure devices (printers, copiers, displays, switches): procure Energy Star or EPEAT equipment, consolidate and centralize printers and copiers to allow for more effective power management and efficient use of consumables, investigate and deploy power management technologies for network infrastructure.

In addition to targeting specific equipment used across Grounds, as an academic institution, UVA is positioned to conduct research on developing efficient IT systems. One such example is exploring development of a technology center to replace existing data centers within a complex dedicated to efficiently hosting, powering, cooling, and recovering heat generated by the data center for building-related needs. A technology center could include office, collaboration, development, and classroom spaces, which all interact as a comprehensive system rather than operating in isolation.

Furthermore, IT systems can be used as a means for reducing other sources of emissions at the University. For example, transportation can be reduced by facilitating virtual meetings using video conferencing and through additional opportunities for telecommuting.

Offsets

UVA is committed to meeting its GHG reduction goal by prioritizing internal emissions reductions. If these strategies are not enough to meet the 2025 goal, however, UVA recognizes the need to offset emissions as a short-term solution. Offsetting emissions on a short-term basis would allow UVA to cover any identified gap between UVA's GHG reductions and the reduction target.

As 2025 approaches, UVA's Offset Task Force will continue to evaluate GHG offset approaches aligned with the Second Nature Carbon Markets & Offsets principles. These principles "ensure that all offsets are of the highest quality as they (universities) make direct investments in carbon offsets or participate in voluntary carbon markets." Second Nature's guidance is used by over 600 colleges and universities.

Second Nature offset principles

Offset projects are real and emissions reductions are additional.

Offset projects are transparent.

Emissions reductions are measurable.

Emissions reductions are permanent.

Emissions reductions are verified.

Offset projects are synchronous and/or generated after 2009.

Offset projects account for leakage.

Offset projects should consider including co-benefits.

Credits are enforceable.

Credits are registered or follow Second Nature's guidance for innovative/peer-reviewed offsets.

Credits are not double counted.

Credits are retired.

Additionally, UVA will prioritize offsets with aligned co-benefits, such as a local project that provides educational opportunities and/or nitrogen benefits. Approaches to purchasing offsets may include, and are not limited to, purchasing offset credits from the voluntary carbon market, creating and verifying GHG offsetting projects on Foundation property, and the acquisition of renewable energy credits (RECs). As UVA considers creating offset projects on Foundation lands with both carbon and nitrogen benefits, **UVA will follow Second Nature's guidelines for producing peer-reviewed and innovative offsets.**

The Offset Task Force will ensure that offsets can be purchased and retired in a timely manner. If necessary, the Offset Task Force will consider the merits of recommending that UVA establish an offset purchase fund and designate a fiduciary manager responsible for it. This fund could be capitalized through voluntary contributions, such as opt-in payments collected during financial transactions associated with activities that generate GHG emissions. Budget-neutral strategies for capitalizing the fund may include but are not limited to providing UVA community members with the option of offsetting GHG emissions generated through commuting and/or travel, philanthropy, and Athletics sponsorships.

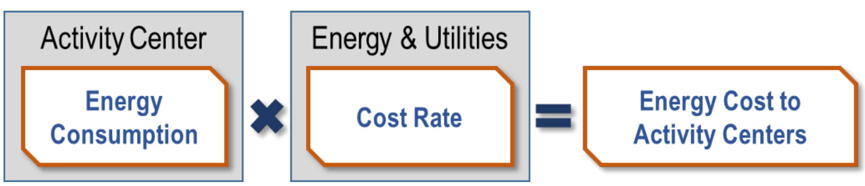
The quantity of offsets purchased from the voluntary market to help meet the stated GHG reduction goal will vary (and may be zero). Additional offset credits may be purchased to achieve other, voluntary reductions (e.g., scope 3 emissions and/or carbon neutral events), as deemed necessary.

Responsibility centered management

Stewardship of our planet's resources was of tantamount importance to Thomas Jefferson. As outlined in the Sustainability Plan for 2016-2020, the University of Virginia recognizes that there is a need for responsibility for sustainability at the institution. Within the University Financial Model, Activity Centers manage their revenue and costs, and are responsible for their financial and academic performance. They are required to steward all assets entrusted to them, including information infrastructure, access to research support, the University Grounds and facilities, human resources, and the intellectual capital of the institution. Responsibility for environmental impact and resource stewardship is a natural progression.

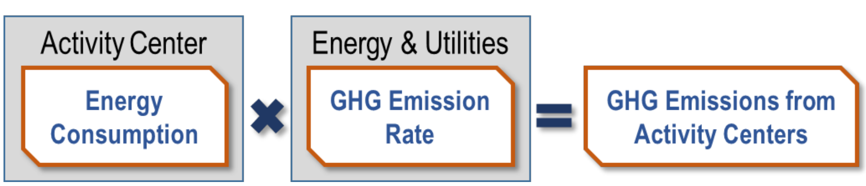
A facility's energy consumption on-Grounds is a result of each Activity Center's operations within the facility. The framework of the University Financial Model migrates responsibility for this energy demand to Activity Centers by billing each Activity Center directly for the energy they consume. As portrayed in Figure 3, this cost is determined by multiplying the energy consumption with the energy cost rate, calculated by Energy and Utilities. This rate is determined from the energy supply and distribution, considering the fuels used, UVA's utility infrastructure, and plant operations. Decreasing one or both variables will decrease total energy cost for the Activity Center. Activity Centers can focus on reducing energy demand while Energy & Utilities will focus improving efficiencies on-Grounds to reduce the rate.

Figure 3: UVA's Responsibility Centered Energy Management Structure



Similarly, as seen in Figure 4, below, determining an Activity's Center GHG footprint will allow each Activity Center to measure, benchmark, and ideally reduce their contribution to the University-wide energy and GHG reduction goals. The Office for Sustainability, working with the Activity Centers, will establish energy reduction goals relevant to each facility and provide a toolkit of resources to facilitate reductions.

Figure 4: Proposed Responsibility Centered GHG Management Structure



This distributed responsibility for sustainability at UVA will drive positive change and yield the successful achievement of UVA's ambitious goals. Additionally, due to the distribution of energy costs already imbedded in the University Financial Model, reduction of energy consumption and GHG emissions will drive a reduction in costs for the Activity Centers.

Next steps

Table 2: GHG Reduction Strategies Next Steps

On-Grounds energy generation

Fuel optimization

- Understand and remove the barriers in natural gas supply to the plant to eliminate the use of coal.

Chilled Water Plants efficiency improvements

- Continue developing in-house expertise with controls, engineering, and operations to facilitate organic development of continuous improvements.

Heat Plant efficiency improvements

- Investigate building loads connected to the Massie Road plant.
- Engineer solutions to specific anomalies identified through analysis of boiler automation data.
- Install a smaller or modulating air compressor to operate when load is diminished.

Distribution efficiency

- Continue engineering efforts to identify, evaluate, and design locations for hubs.
- Identify and engineer solutions to address compatibility of building systems and loads with reduce heating water supply temperatures.
- Construct LTHW hubs in phases with a currently estimated completion by 2020.

Alternative energy technologies

- Continue the engineering and financial analysis of CHP.
- Identify opportunities to strategically develop LTHW district energy plants; coordinate with development on-Grounds.
- Coordinate design and equipment replacement within buildings that will connect to the plants for heating water with a reduced heating capacity due to the lower temperature.

Renewable energy

On-Grounds

- Complete a University-wide roof condition assessment to document the solar potential of each roof, the visibility of systems, the ability for interconnection to energy infrastructure, and document the structural worthiness of roofs to support additional load.
- Develop a reserved funding stream for continuous development of renewable energy projects on-Grounds.
- Finalize Request for Proposals to select and engage a consultant to produce “Solar Road Map” to identify locations and magnitude for PV installations.
- Develop a working group to identify and work through internal obstacles and tolerances for solar energy implementation.
- Develop project specifications and requirements to facilitate rapid expansion.

Off-Grounds utility-scale

- Evaluate the technical and financial viability of additional off-site, utility-scale solar PV projects, as well as utility-scale wind projects.

Existing buildings

Building-specific efficiency improvements

- Develop a scope of work for an Energy Efficiency Master Plan for Health System's portfolio.
- Create and review Energy Efficiency Master Plan, along with the list of upcoming renovation and construction projects, to help expedite increase the rollout of energy efficiency projects in the Health System.

Systematic technology rollout

- Develop a funding mechanism that works within the University's responsibility-centered financial model where lighting or other technology replacements are implemented prior to a whole-building efficiency project funded through the Delta Force program.
- Develop a process for engaging building occupants and school, unit, auxiliary, and/or cost center leadership to move projects forward.
- Finalize contracts with material vendors.
- Finalize process for mocking up LED retrofit options to facilitate rapid project design and faster implementation.
- Continue thermographic imaging of building envelopes.

Controls optimization/replacement

- Implement standard practice for Automation Services to move through buildings.
- Review and optimize building controls, focusing on buildings with automation systems that have been installed within the past ten years and wholesale replacement is not warranted.
- Reconfigure Delta Force funding mechanism to incorporate new BAS optimization results that will occur before Delta Force intervention.
- Assign a full-time program manager for the planning and implementation of the controls optimization effort.

Preventive maintenance refinement and training

- Identify key individuals to support the refinement of PM procedures.
- Validate and update PM procedures for each building in UVA's CMMS.
- Establish working group for PM refinement with representatives from Office for Sustainability, Automation Services, and Facilities Maintenance.
- Update the CMMS with improved and sustainability-focused PM activities, based on recommendations from the working group.
- Refine and develop new mandatory training courses to cover the revised PM procedures and activities.
- Acquire any required tools and instruments to facilitate maintenance staff in executing PM procedures.

Operations & maintenance staff sustainability engagement

- Identify an engaged individual from each O&M team as the Sustainability Steward.
- Create and convene the O&M Sustainability Stewards and establish target milestones for developing and implementing operational changes.
- Consult the Office for Sustainability to help develop metrics to measure the impacts of the potential changes.
- Evaluate the feasibility of implementing suggested changes, and compare the value of these changes as the concepts are being developed.

Green labs

Equipment improvements & individual engagement

- Organize a comprehensive lab equipment improvement program through a collaborative effort between Green Labs stakeholders.
- Add cage washer replacements and vacuum/compressed air upgrades into the scope of work for lab buildings in which Delta Force is already working.
- Identify test labs that would be willing to pilot the freezer management program and use shut-off timers on their lab equipment. Based on these results, consider implementing successful efforts into the Green Labs Program.

Infrastructure modifications

- Develop a task force of key stakeholders to draft and present a University-wide laboratory ventilation management program for new and existing labs.
- Build inventory of all fume hoods on-Grounds and target poor performing hoods for replacement.
- Identify opportunities for Delta Force team to implement Mechanical, Electrical, and Plumbing optimization.

New construction & major renovations

- Finalize and adopt the Green Building Standards in 2017.

Transportation

Commuting

- Analyze previous survey results to prioritize commuting improvement efforts.
- Conduct a mode split survey in 2017 to review commuting trends, employee knowledge of transportation programs, and the obstacles that prevent employees from using alternative transportation.
- Implement new transportation programs and make adjustments/improvements to existing programs.

Buses

- Identify opportunities to reduce idling time and vehicle miles traveled on both regular fixed route service and during charters trips.
- Continue to monitor the existing bus fleet through its self-operated Maintenance Division to manage the proposed long-range fleet replacement plan.
- Review UTS engine diagnostic information to help develop an idling policy to reduce emissions and operating costs.
- Continue to replace buses with Automated Passenger Counters that track passenger boarding and alighting by location and time.

Fleet vehicles

- Continue to right size the fleet through the FM Fleet Management's LEAN Initiative.
- Identify potential membership for a Fleet Management Working Group to work on developing resources like a "Vehicle Replacement Matrix," a "Vehicle Type Matches the Business Need" report, and a "Vehicle Lifecycle/Replacement Plan."
- Solicit or procure services(s) to implement pilot fuel management software modifications and measure results.

Awareness and individual action

Occupant energy and sustainability engagement

- Leverage support from leadership to clearly communicate to all staff that participation in relevant programs is not only encouraged but part of the mission of their work as responsible stewards of UVA's resources.
- Draft language for public statement for energy conservation programs.
- Identify specific strategies and targets for each building type and corresponding audience.

Green IT

- Work with interdepartmental workgroups to develop catalogue of IT equipment.
- Solidify procurement policies and education of the benefits of more efficient IT equipment options.
- Develop energy efficient power setting standards and deploy across the University through procurement channels such as Cavalier Computers.

Offsets

- Evaluate the potential need for offsets annually as the inventory is documented, projections are refined, and new information about offsets is received.
- Establish Carbon Offset Task Force to engage subject matter experts to make recommendations on types of offset projects to pursue - those with most aligned co-benefits, and a comparison of registries and vendors, which vendors to use.
- Discuss the implications, benefits, and challenges of applying a cost of carbon, whether based on market costs or social costs, to UVA's cost-benefit analyses.