



NC STATE
UNIVERSITY



2018 STRATEGIC
ENERGY AND WATER
ANNUAL REPORT

Energy and water are among NC State's most necessary and costly expenses. For more than a decade, the university's campus-wide energy management strategies have resulted in significant conservation of these vital fiscal and environmental resources. This report provides current and future project highlights, an update on utility reduction progress, and NC State's energy and water goals.

HIGHLIGHTS

The following are highlights and accomplishments of energy efficiency strategies implemented during fiscal year 2018:



Through collaboration among business units within the Facilities Division, Energy Management compiled the fiscal year 2018 Reinvestment Act claim for more than \$3.8 million in energy savings. The Reinvestment Act of 2010, also known as NC House Bill 1292, allows NC institutions to capture a portion of energy and water savings for reinvestment in future conservation projects.



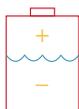
Construction is complete and NC State will soon take ownership of the Combined Heat and Power project in the Centennial Campus Central Utility Plant. This project will generate nearly \$1.6 million in annual savings and is funded through NC State's fourth energy performance contract.



Energy Management successfully funded more than \$1.3 million of campus energy projects that result in annual savings of \$250,000. Multiple projects ranging from lighting upgrades to building controls improvements were completed through cost-sharing programs with campus partners.



NC State purchased the Centennial Campus electric substation from Duke Energy Progress. Owning the substation allows NC State to purchase electricity at a reduced rate. This rate reduction saved NC State \$130,000 in transmission costs during fiscal year 2018.



Design is complete on Thermal Energy Storage (TES) at the Centennial Campus Central Utility Plant, and construction is scheduled to begin in fiscal year 2019. TES will store 3.4 million gallons of chilled water, offsetting the need to operate electrically driven chillers during on-peak hours. This reduces electrical expenses.



The Facilities Division Commissioning Team's work continues to improve the efficiency of campus buildings through mechanical equipment calibrations, sequence adjustments and schedule implementations. The Commissioning Team's cumulative utility savings is more than \$1 million.

SAMPLING OF PROJECTS COMPLETED DURING FISCAL YEAR 2018

PROJECT	BUILDING(S) IMPACTED	COST	ESTIMATED ANNUAL COST AVOIDED
EcoAdvance Outdoor Air Reduction System	Engineering Building II	\$111,470	\$25,000
Recommissioning and Controls Upgrade	D.H. Hill Library	\$103,215	\$150,000
Recommissioning	Toxicology	\$67,348	\$16,000
Events2HVAC Pilot Project	Park Shops, SAS Hall	\$8,438	\$2,000
Window Film	1911 Building	\$36,866	\$10,000
Complete Building LED Lighting	Price Music Center	\$52,745	\$5,400
Chiller Bay LED Lighting	Yarbrough Steam and Chilled Water Plant	\$15,953	\$2,300
Interior LED Lighting	Partners III Suite 1500 (Chancellor's Faculty Excellence Program)	\$19,320	\$1,850
Instantaneous Hot Water Heaters	Schaub Hall	\$60,070	\$5,900
Holiday Energy Savings Initiative	Campus-wide	\$0	\$202,000
Summer Classroom Scheduling	Campus-wide	\$0	\$67,000

SUCCESS STORIES



The original windows at the historic 1911 Building were upgraded with a **ceramic solar window film**, which will save on energy costs and improve thermal comfort in the building.



Collaborative efforts to **reduce HVAC costs** over winter break and during the summer yielded nearly \$270,000 in avoided utility costs.



Price Music Center was updated with 100% **LED lighting**. This is the first building on NC State's campus to earn this distinction. Estimates indicate the building will save \$5,400 on electricity costs annually.



Energy Systems installed four **EcoAdvance HVAC Load Recovery Units** at Engineering Building 2. The units save energy by cleaning and recycling conditioned air, reducing outside air intake. Completed in June, the project will generate \$25,000 in annual savings.



Energy Management funded the replacement of approximately 40 **steam traps** in campus utility plants and distribution tunnels. This maximizes efficiency by ensuring high steam quality and condensate return.



Recommissioning efforts in D.H. Hill Library have shown savings of \$100,000 in just the first 8 months.

ENERGY PERFORMANCE CONTRACTING

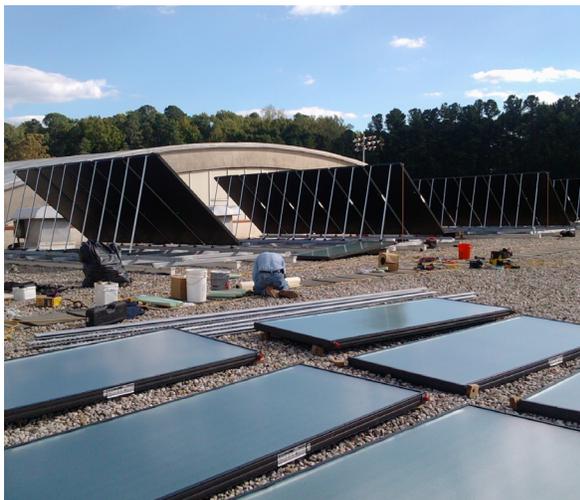


COGENERATION EPC ON CENTRAL AND NORTH CAMPUS (2012)

Investment: \$56.1 million

Contract Duration: 17 years

In 2012, this project replaced aging boilers in both the Cates and Yarbrough Central Utility Plants with new high efficiency boilers and a cogeneration system. The cogeneration system, which is also called combined heat and power, utilizes natural gas to produce 11 megawatts of electricity while the waste heat from the process produces steam. Utility savings are realized due to a reduction in the total cost of electricity and steam production through increased efficiency. In addition, the new system reduced the campus greenhouse gas emissions by 8% (approximately 33,000 EMTCO₂).



13 BUILDING EPC (2012)

Investment: \$19.7 million

Contract Duration: 19 years

The 13 Building EPC encompasses the following buildings: Cox Hall, Poe Hall, Tompkins Hall, Caldwell Hall, Winston Hall, College of Textiles, McKimmon Center, Monteith Research Center, Research I, Dabney Hall, Carmichael Gym, Constructed Facilities Lab and MRC Parking Garage. The EPC included renovations and operational changes with the HVAC systems and fume hood controls, lighting upgrades, water reduction strategies and a solar hot water system in Carmichael Gym. The utility savings for fiscal year 2018 were \$1.7 million.

NC State utilizes energy performance contracting (EPC) to upgrade facilities and systems, avoid operational expenses and reduce emissions. The university currently has three EPCs and is taking ownership of a fourth EPC at the end of 2018. The four EPCs represent an investment of \$98 million and a projected annual utility cost avoidance of \$8.2 million. Each EPC is fully funded through energy savings generated by improved efficiency.

PHYTOTRON BUILDING EPC (2014)

Investment: \$6.2 million
Contract Duration: 15 years

Constructed in 1968, the Phytotron Building performs plant, animal and insect research by simulating environments from desert heat and drought to Alpine cold and jungle humidity. The Phytoron EPC addressed HVAC and lighting upgrades, as well as a connection to the central chilled water loop and research equipment improvements. Energy savings in Phytotron were in excess of \$500,000 in fiscal year 2018.



CENTENNIAL CAMPUS COGENERATION EPC (2018)

Investment: \$17 million
Contract Duration: 18 years

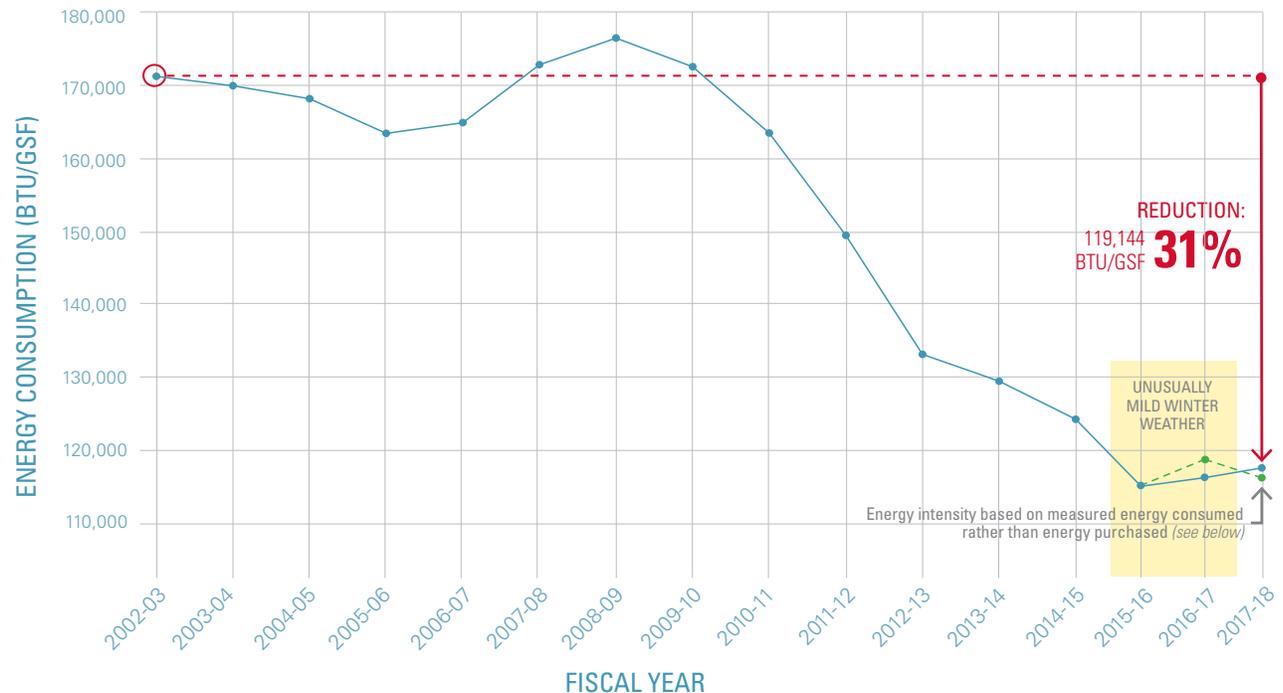
The Centennial Cogeneration EPC removed a boiler in the Centennial Central Utility Plant and installed a high efficiency cogeneration system. The cogeneration system utilizes natural gas and steam to produce 6.5 megawatts of electricity and the waste heat from the process produces steam. Utility savings are realized due to a reduction in the total cost of electricity and steam production through increased efficiency. The new system is projected to also reduce the campus greenhouse gas emissions by about 4% (approximately 16,000 EMTCO₂).



ENERGY

Total energy consumption per gross square foot peaked in 2008-2009 and has trended downward since. Compared to the fiscal year 2002-2003 baseline, this energy use intensity (EUI) has decreased by 31%.

NC STATE ENERGY USE INTENSITY (BTU/GSF)



*Combined Heat and Power (CHP) Adjustment Methodology: NC State purchases electricity, natural gas, fuel oil, potable water and reuse water from third parties. Electricity is also generated on campus using an 11 megawatt (MW) CHP system. As a result of CHP, fuel use for on-site power generation increases, fuel use for boilers decreases, and grid electricity purchases (or source energy) decreases. The methodology for reporting the benefits garnered through the operation of CHP follows the U.S Department of Energy measurement protocol outlined by the Federal Energy Management Program in the *Reporting Guidance for Federal Agency Annual Report on Energy Management* issued September 2015. The purpose of the adjustment is to not penalize organizations under the site energy based performance metric for implementing cost-effective projects where source energy decreases but site-delivered energy increases.

WHY DID ENERGY USE INTENSITY INCREASE SLIGHTLY THIS YEAR?

The increase in EUI this fiscal year is largely attributable to two reporting requirements. First, NC State is required to report energy *purchases* rather than measured energy consumption. This year, a significant amount of fuel oil (amounting to 5% of campus total utility expense) was purchased to replenish fuel oil tanks. Fuel oil is a backup fuel at the central utility plants when natural gas is not available. Fuel oil is stored in large tanks at each central plant, and the tanks are filled based on the tank levels and availability of funds. NC State typically relies on this backup fuel source twice per year and had not made a significant fuel oil purchase since fiscal year 2016. The dotted green line in the graph above illustrates what the energy intensity would be

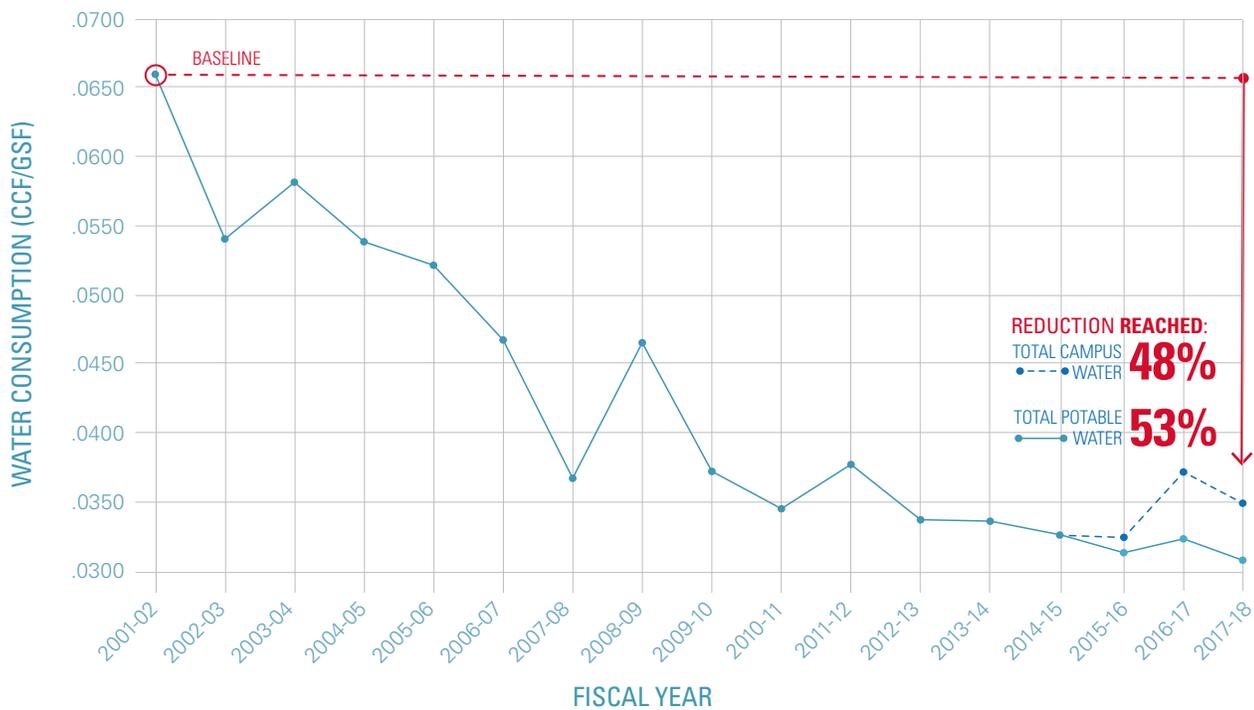
if based upon measured energy consumption rather than energy purchased. Second, campus energy data is required to be reported in its raw format and not weather normalized, which would account for variations in weather from year to year. The winter periods of the previous two fiscal years were mild as compared to the 30-year weather average, which reduces the need for heating and therefore natural gas. In contrast, the winter weather during fiscal year 2018 was much closer to average, which required additional energy use for heating. When these two reporting requirements are taken into account, it appears that NC State remains on a steady path to reducing its energy use intensity.

WATER

In fiscal year 2016, NC State began utilizing reuse water supplied by the City of Raleigh on Centennial Campus. Reuse water, sometimes called reclaimed water or non-potable water, is wastewater treated to a high standard and reused instead of being discharged into a waterway. Reuse water provides a cost-effective and drought resistant supply of water for cooling towers, irrigation and toilet flushing. For total water consumption (potable and reuse), fiscal year 2018 marked a level 48% below the 2001-2002 baseline. Potable water consumption alone has decreased by 53%.

WATER CONSUMPTION PER GSF

1 CCF = 748 GALLONS



WHY DOES REUSE WATER INCREASE TOTAL WATER CONSUMPTION?

Although reuse water is less expensive and more drought resistant than potable water, the central plant cooling towers use more reuse water to perform the same function of providing cooling to the campus. Cooling towers function by evaporating water for cooling. When water evaporates, any impurities in the water are left in the cooling tower basin and must be drained

regularly. Because reuse water has a higher concentration of impurities than potable water, the cooling tower basins must be more frequently drained, which increases water use. However, the benefits of reuse water – primarily decreased cost and drought resistance – outweigh the additional water use.

PROGRESS

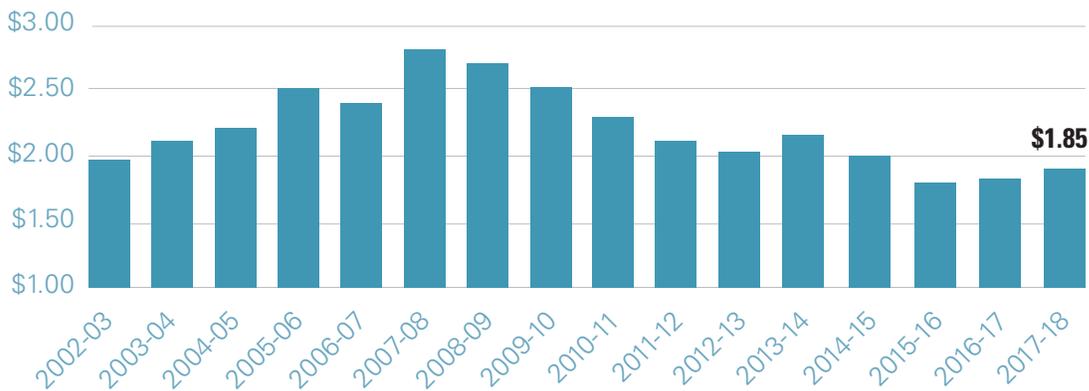
ENERGY AND WATER EXPENSES



Of the \$27.7 million NC State spent on energy and water during fiscal year 2018, electricity accounts for more than half. Electricity is the utility most influenced by the campus community and, as such, has the greatest potential for reduction through

conservation actions. Turning off lights, unplugging electronics not in use, closing windows and doors, and shutting fume hood sashes in labs all help reduce electric consumption.

UTILITY COST PER GSF



Both EUI and total utility cost per GSF have shown solid, downward trends over the last 9 years. For fiscal year 2018 the total utility cost per GSF is \$1.85/GSF. This is 6.6% lower than the baseline despite energy prices that have increased by 22% and water prices that have increased by 347% since 2002-03. Energy and water efficiency gains, coupled with Energy Management’s strategic purchasing of natural gas, have all contributed to the gradual reduction

in total utility cost per GSF. The increase in total utility cost per GSF for fiscal year 2018 relative to the previous two years is associated with both the increase in energy use intensity (which was affected by the reporting being based upon consumption rather than purchases, and not being weather normalized), as well as increases in utility prices during the past year.

KEY PERFORMANCE INDICATORS (KPI)

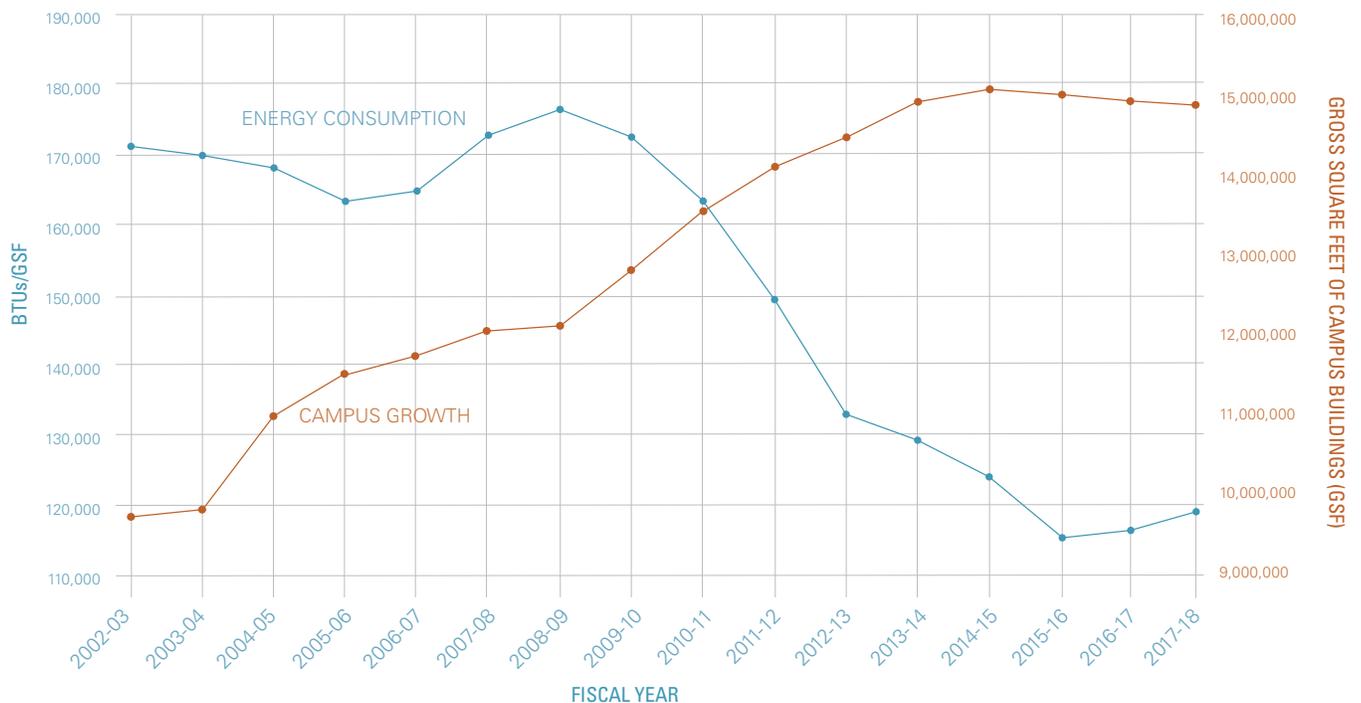
FISCAL YEAR	2001-02*	2002-03	2012-13	2013-14	2014-15	2015-16	2016-17	2017-2018	% CHANGE (1 YEAR)	% CHANGE FROM BASELINE
UTILITY COST, \$ / GSF		\$1.98	\$2.05	\$2.18	\$1.99	\$1.78	\$1.80	\$1.85	2%	-7%
ENERGY COST, \$ / GSF		\$1.87	\$1.83	\$1.93	\$1.74	\$1.52	\$1.53	\$1.58	3%	-16%
WATER COST, \$ / GSF	\$0.12	\$0.11	\$0.22	\$0.25	\$0.24	\$0.26	\$0.28	\$0.27	-4%	127%
ENERGY CONSUMPTION (BTU / GSF)		171,810	132,331	128,518	123,115	115,692	116,763	119,144	2%	-31%
POTABLE WATER CONSUMPTION (CCF / GSF)	0.066	0.054	0.034	0.034	0.033	0.032	0.034	0.031	-9%	-53%
TOTAL WATER CONSUMPTION (CCF / GSF)	0.066	0.054	0.034	0.034	0.033	0.034	0.037	0.035	-5%	-47%
CAMPUS AREA GROSS SQUARE FEET (GSF)	9,796,638	9,910,619	14,453,596	14,966,918	15,144,558	15,119,248	14,978,780	14,972,547	0%	51%

*Baseline year for water cost and consumption per gsf is fiscal year 2001-2002 as defined in Executive Order Number 26. For all other KPIs, the baseline year is fiscal year 2002-2003.

■ Baseline

ENERGY USE INTENSITY AND CAMPUS GROWTH

The following figure illustrates the university's growth and EUI over time. As indicated by this figure, the university continues to make significant progress in reducing its EUI through the inclusion of energy efficiency strategies in new and renovated building space.



STRATEGIC GOALS

The following goals were established in 2017 as part of development of NC State's Sustainability Strategic Plan. The goals will be completed or re-assessed by 2022.

GOAL 1: REDUCE TOTAL CAMPUS ANNUAL ENERGY USE PER SQUARE FOOT BY 40% FROM THE 2002 BASELINE.

Strategy A: Optimize building energy usage through retro-commissioning, continuous commissioning, maintenance and occupant education.

Tactic 1a: Create a Building Energy Assessment Tool (BEAT) that establishes EUI targets and compares those to actual EUIs for the buildings. *Complete*

Tactic 1b: Utilize the BEAT to determine buildings that require re-commissioning, auditing, equipment repair, energy efficiency projects or major renovation. *In Progress - ongoing effort to address issues in the buildings*

Tactic 2: Set EUI targets for all new capital projects.

Tactic 3: Require building envelope commissioning in new capital projects.

Tactic 4: Implement a predictive maintenance program for research buildings.

Tactic 5: Convert buildings to direct digital control (DDC) and upgrade obsolete DDC controls. *In Progress - upgrades being conducted with annual energy funds*

Tactic 6: Use a phased approach to switching air handler unit filter media to new technology to reduce energy, labor and filter media waste.

Strategy B: Explore and develop best practices for intelligent infrastructure and energy generation use in campus buildings.

Strategy C: Reduce energy use within the five central utility plants by 5% from the 2015 baseline.
On Hold - awaiting major renovations in the CBC and Centennial Central Utility Plants to be completed

GOAL 2: EXPAND THE AMOUNT OF RENEWABLE ENERGY USED TO MEET NC STATE'S NEEDS.

Tactic 1: Research large scale renewable energy options available within NC utility regulations. *In Progress - Solar Capacity Study will be performed through a joint venture with the NC State Energy Collaborative in Spring 2019*

GOAL 3: REDUCE CAMPUS WATER CONSUMPTION BY 65% FROM THE 2001 BASELINE.

Strategy A: Expand the use of reuse (reclaimed or non-potable) water on campus.

Strategy B: Reduce water use in campus buildings and central utility plants.

Tactic 1: Perform building surveys to assess previously installed water management devices. *In Progress - surveys will be complete in late 2018*

Tactic 2: Perform central plant water use analysis and investigate potential water saving technologies.

GOAL 4: REDUCE NC STATE'S TOTAL GREENHOUSE GAS EMISSIONS BY 25% FROM THE 2008 BASELINE.

Tactic 1: Complete the next greenhouse gas inventory based on the 2016-2017 fiscal year. *Complete*

Tactic 2: Implement combined heat and power project on Centennial Campus. *In Progress - project will be complete in late 2018*

FISCAL YEAR 2019 PLANS

The following projects are planned for fiscal year 2019.

PROJECT	BUILDING(S) IMPACTED	ESTIMATED COST	ESTIMATED ANNUAL COST AVOIDED
Recommissioning	Terry Hospital	\$75,000	TBD
Controls Upgrade	Jordan Hall	\$94,300	TBD
ULT Freezer Rebate Program	Various Academic Buildings	\$50,000	\$11,000
Main Entrance Interior Lighting	D.H. Hill Library	\$60,000	\$8,694
Rainwater Catchment Tank	Centennial Campus Utility Plant	\$10,000	TBD
Exhaust Fans Controls	MRC Parking Deck	\$15,000	TBD
Events2HVAC Expansion	David Clark Labs, Poe, Winston, Tompkins	\$8,000	\$4,000
Phase Change Technology Pilot Project	TBD	\$30,000	TBD
Cinema LED Lighting	Witherspoon Student Center	\$118,000*	\$2,100
LED Lighting	Isenhour Tennis Center	\$90,000	\$10,400
LED High Bay Lighting	Weisiger-Brown Athletics Facility	\$48,000	\$14,600
LED High Bay Lighting	Centennial Campus Utility Plant	\$20,000	\$6,000
Building-Attached Exterior LED Lighting	Various Main Campus Buildings	\$55,000	\$9,700
Steam Trap Replacement Program	Campus Utility Plants	\$15,000	\$30,000
Boiler Tune Ups	Campus Utility Plants	\$23,000	\$10,000

* Cost share with Campus Enterprises

The Strategic Energy and Water Annual Report
is produced by NC State Energy Management

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