

**NC STATE**  
UNIVERSITY



2017 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 enabled significant conservation of vital fiscal and environmental resources. This report provides an update on campus progress toward utility reductions, highlights specific projects and outlines strategies for the next fiscal year that will contribute to further reductions.

## HIGHLIGHTS

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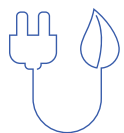
The following are highlights and accomplishments of energy efficiency strategies and energy-related projects implemented on campus during fiscal year 2016-2017:



Through collaboration among business units within Facilities Division, Energy Management compiled the fiscal year 2016-2017 Reinvestment Act claim for more than \$3.5 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 further conservation projects.



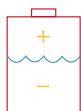
After five years of successful operation and a generated savings of more than \$5.3 million annually, the first combustion turbine generator (CTG) engine change-out was successfully conducted at the Cates Combined Heat and Power (CHP) utility plant on central campus. The two new CTG engines will power the CHP system for the next five years.



Energy Management successfully funded more than \$1.1 million of campus energy projects that resulted in projected annual savings of \$304,000. Multiple projects ranging from lighting upgrades to building controls improvements were completed through cost-sharing programs with campus partners.



At the culmination of a two-year planning and design effort, construction began on the CHP project in the Centennial Campus Utility Plant in May 2017. This 6.5 megawatt project will generate nearly \$1.6 million in savings annually and will be funded through NC State's fourth energy performance contract (EPC).



Design efforts for Thermal Energy Storage (TES) at the Centennial Campus Central Utility Plant began. TES will store 3.4 million gallons of chilled water and offset campus electrical demand and consumption during the day when electricity prices are high.



Smart Building technologies for energy efficiency have been incorporated into the design process for two major campus buildings in design: Engineering Building Oval and the Plant Sciences Building. These technologies will enable an enhanced occupant experience and energy reduction capabilities in both buildings.

## ENERGY PROJECTS COMPLETED DURING FISCAL YEAR 2017

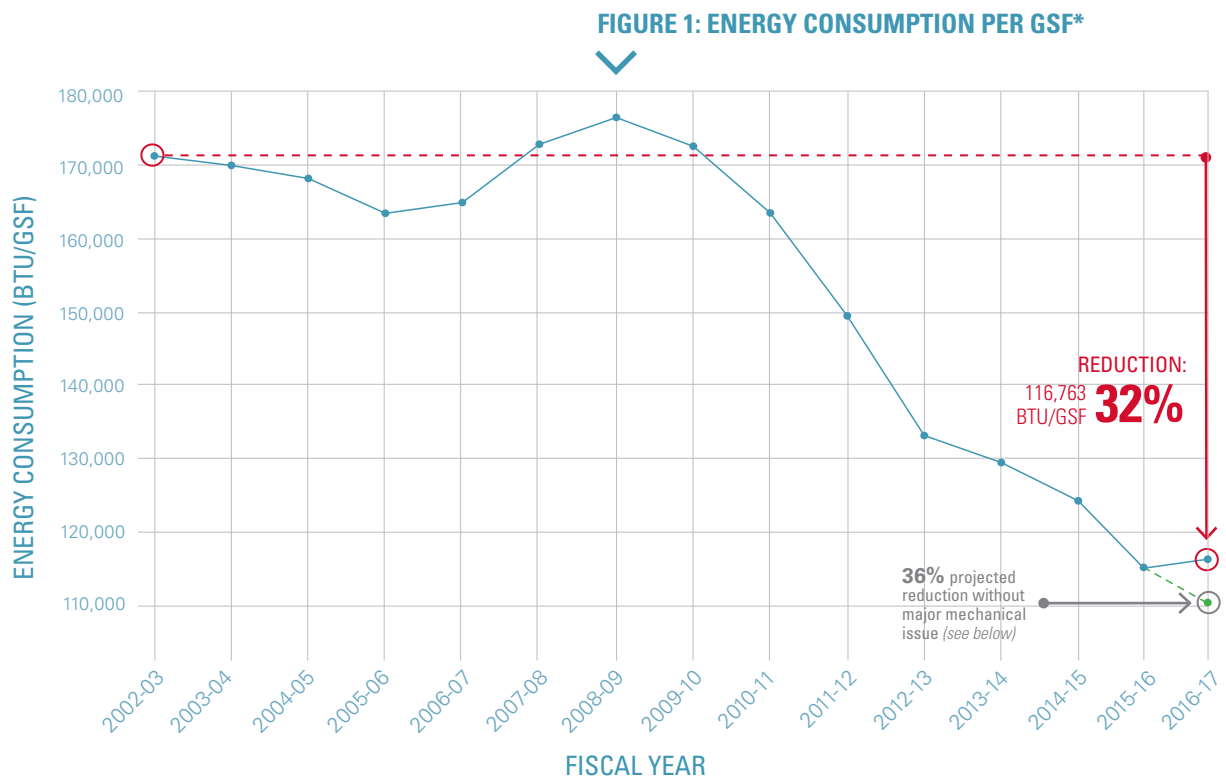
PROJECT	BUILDING(S) IMPACTED	COST	ESTIMATED ANNUAL COST AVOIDED
Annual Steam Trap Replacement Program	Campus Steam System	\$38,000	\$124,760
Annual Boiler Tuning	Campus Utility Plants	\$23,300	\$52,242
Combined Heat and Power Combustion Turbine Generator (CTG) HEPA Filter Replacement	Cates Central Utility Plant	\$16,200	\$140,200
Variable Frequency Drive Installation on Chilled Water Pump	Cates Central Utility Plant	\$69,700	\$10,105
Inlet Cooling Water Harvesting	Cates Central Utility Plant	\$9,300	\$8,206
Lighting Project, rooms 1201-1216	College of Textiles	\$28,900	\$4,200
Restroom Lighting Project	Witherspoon Student Center	\$5,800	\$1,500
Holiday Energy Savings Initiative (HESI)	Campus wide	\$0	\$267,400
Summer Energy Saving Initiative (SESI)	Campus wide	\$0	\$123,400

## SAMPLING OF PROJECTS PLANNED FOR FISCAL YEAR 2018

PROJECT	BUILDING(S) IMPACTED	ESTIMATED COST	ESTIMATED ANNUAL COST AVOIDED
LED Lighting	Polk Hall	\$180,000	\$31,000
LED Lighting	Witherspoon Theater	\$30,000	\$10,000
LED Lighting	Price Music Center	\$24,800	\$5,400
LED Exterior Lighting	D.H. Hill, Bostian, Williams	\$45,000	\$7,700
Indoor Air Quality Enhancement	Engineering Building II	\$90,000	\$26,000
Annual Steam Trap Replacement Program	Campus Steam System	\$35,000	\$12,000
Solar Window Film	1911 Building	\$50,000	\$10,000
Condenser Water Variable Frequency Drive installation	Yarbrough Central Utility Plant	\$70,000	\$12,000
Annual Boiler Tuning	Campus Utility Plants	\$23,000	\$10,000
HVAC Controls Upgrade	Kilgore	\$178,000	\$32,000
Recommissioning	D.H. Hill	\$90,000	\$52,000
Persistent Commissioning Project	Phytotron	\$30,000	\$15,000
Utility Piping Re-insulation	Polk Hall	\$30,000	\$5,000
Recommissioning	Toxicology	\$70,000	\$16,000
Hot Water Heater Replacements	Schaub Hall	\$40,000	\$6,000

# ENERGY

Campus energy consumption peaked in fiscal year 2008-2009 and has trended downward since. Compared to the fiscal year 2002-2003 baseline, total energy consumption per gross square foot (GSF) has decreased by 32% (see Figure 1).



\**Combined Heat and Power Adjustment Methodology:* NC State purchases electricity, natural gas, fuel oil, and potable 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 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 CONSUMPTION INCREASE SLIGHTLY?

Overall savings decreased due to two factors at the Cates Utility Plant, where combined heat and power (CHP) technology is the single largest contributor to campus energy efficiency. First, both CHP combustion turbine generators (CTGs) underwent their first five-year planned engine change-outs. This process resulted in approximately two weeks of CTG downtime where the machines did not produce electricity. Second, a material issue with auxiliary equipment supporting one of the CTGs, which was discovered during the engine change-out

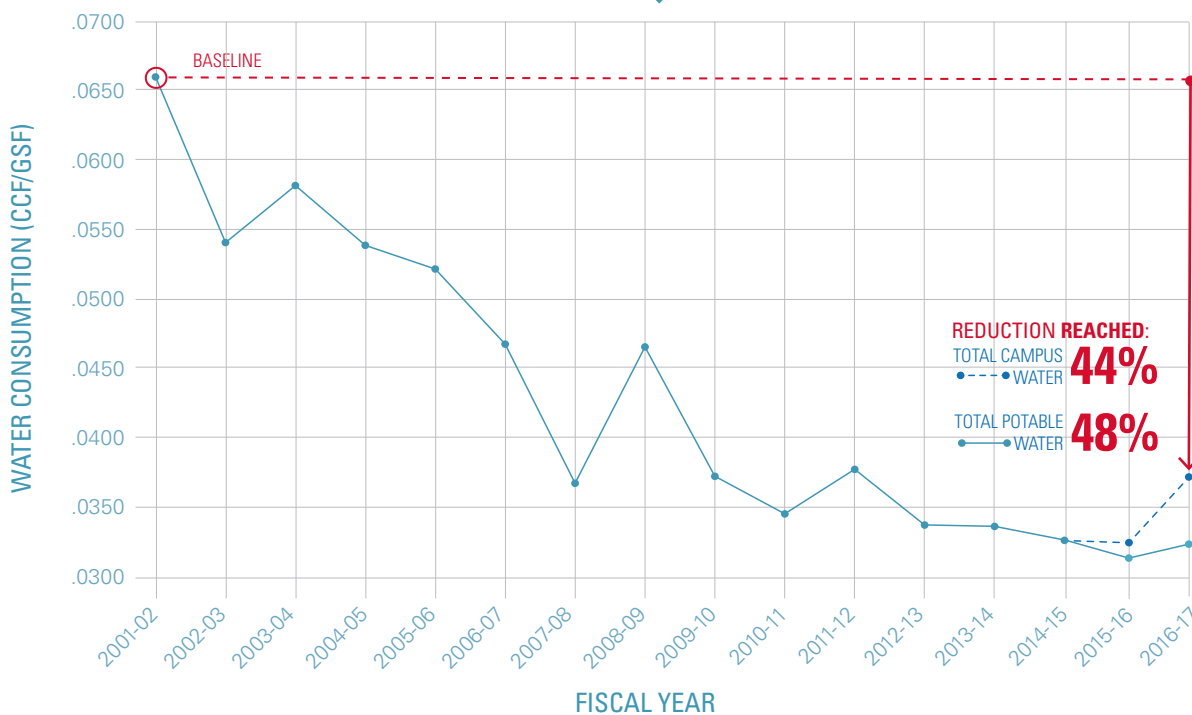
maintenance, caused approximately one additional month of turbine downtime. The combined effect of these events led to 8.5% less electrical generation during fiscal year 2016-2017 and increased campus BTU/GSF. It is important to note that if the CTGs had operated as expected, campus energy use intensity would have been approximately 110,400 BTU/GSF, a reduction of 36% from the baseline. The green dotted line on the graph represents this projected reduction and illustrates the effectiveness of ongoing efficiency efforts campus-wide.

# WATER

In fiscal year 2015-2016, 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 more cost-effective and drought resistant supply of water for cooling towers, irrigation and toilet flushing. For total water consumption (potable and reuse), fiscal year 2016-2017 marked a level 44% below the fiscal year 2001-2002 baseline. Potable water consumption has decreased by 48% (see Figure 2).

**FIGURE 2: WATER CONSUMPTION PER GSF**

✓ 1 CCF = 748 GALLONS



### WHY DID WATER CONSUMPTION INCREASE SLIGHTLY?

Three major factors contributed to the increase in water use. First, more reuse water is required in campus utility plant cooling towers due to the differences between reuse water and potable water.\* Therefore, total water use increases despite the reduction in potable water use. A second factor is the repair of several malfunctioning irrigation systems that had not been used for several years. Lastly, the campus underground steam system had several leaks, which maintenance staff repaired in the fourth quarter of this fiscal year.

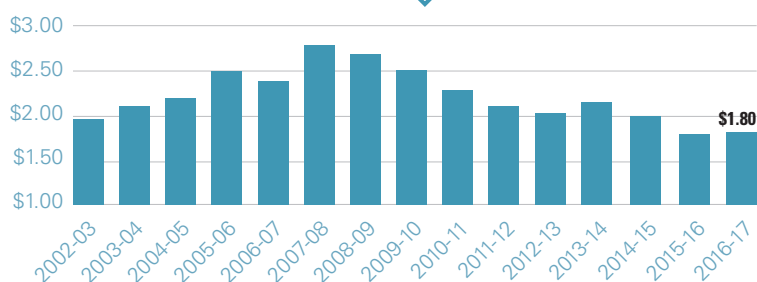
*\*Cooling towers function by evaporating water for cooling. When water evaporates any impurities in the water are left in the cooling tower basin and must be drained regularly. Because reuse water has a higher concentration of impurities than potable water, the cooling tower basins must be more frequently drained, which increases water use. However, the benefits of reuse water -- primarily decreased cost and drought resistance -- outweigh the additional water use.*

# PROGRESS

Both energy consumption per gross square foot (GSF) and utility costs per GSF have shown solid, downward trends over the last 8 years. For fiscal year 2016-2017 the cost per GSF is \$1.80/GSF, 9% lower than the baseline. Energy and water efficiency gains, coupled with low natural gas prices and Energy Management's strategic purchasing of natural gas\*, have all contributed to the gradual reduction in utility cost intensity.

\*The cost paid for natural gas increased by approximately 5% in fiscal year 2016-2017 (from \$4.25 to \$4.48/dth) but still remained well below the 10-year average (\$6.04/dth).

FIGURE 3: UTILITY COST PER GSF



ELECTRICITY (57%)

NATURAL GAS (28%)

WATER (15%)

Of the \$27 million NC State spent on utilities during fiscal year 2016-2017, electricity accounts for nearly 60%. Electricity is the utility most influenced by the campus community and, as such, has the greatest potential for reduction through conservation actions such as turning off lights, unplugging electronics not in use, closing windows and doors, shutting fume hood sashes in labs and turning off computers not in use.

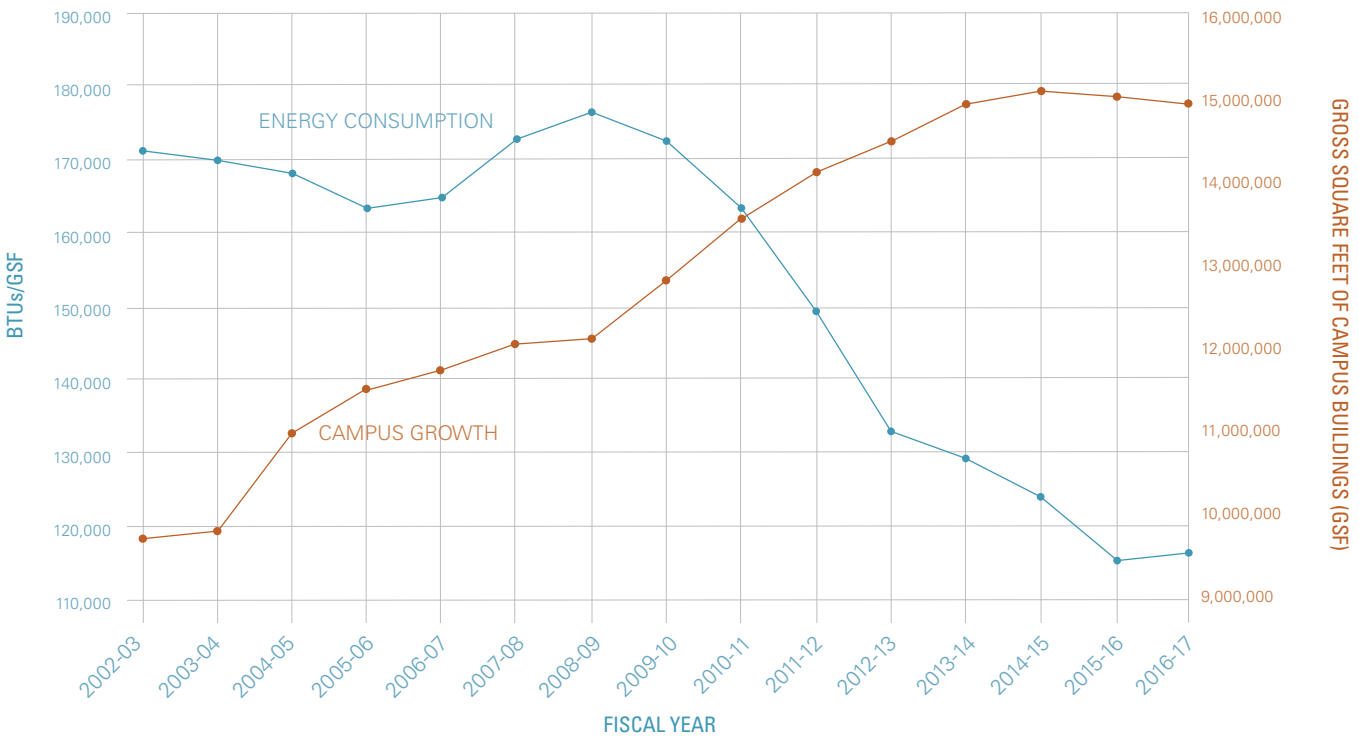
TABLE 1: KEY PERFORMANCE INDICATORS (KPI)

FISCAL YEAR	2001-02*	2002-03	2012-13	2013-14	2014-15	2015-16	2016-17	% CHANGE (1 YEAR)	% CHANGE FROM BASELINE
UTILITY COST, \$ / GSF		\$1.98	\$2.05	\$2.18	\$1.99	\$1.78	\$1.80	1%	-9%
ENERGY COST, \$ / GSF		\$1.87	\$1.83	\$1.93	\$1.74	\$1.52	\$1.53	1%	-18%
WATER COST, \$ / GSF	\$0.12	\$0.11	\$0.22	\$0.25	\$0.24	\$0.26	\$0.28	8%	135%
ENERGY CONSUMPTION BTU / GSF		171,810	132,331	128,518	123,115	115,692	116,763	1%	-32%
POTABLE WATER CONSUMPTION CCF / GSF	0.066	0.054	0.034	0.034	0.033	0.032	0.034	6%	-48%
TOTAL WATER CONSUMPTION CCF / GSF	0.066	0.054	0.034	0.034	0.033	0.034	0.037	9%	-44%
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	-0.9%	51%

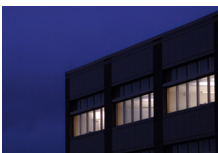
\*Baseline year for water cost and consumption per gsf is fiscal year 2001-2002 as defined in Executive Order Number 26. For all other KPIs, the baseline year is fiscal year 2002-2003.

Figure 4 illustrates the university’s growth and total energy consumption over time. As indicated by this figure, the university continues to make significant progress in reducing its rate of energy consumption through energy efficiency strategies and efforts by the campus community. The slight increase in energy consumption from fiscal year 2015-2016 to fiscal year 2016-2017 is attributed to the aforementioned maintenance and material issues at the Cates Utility Plant (see page 4).

**FIGURE 4: TOTAL ENERGY CONSUMPTION (BTU/GSF) AND CAMPUS GROWTH (GSF)**



**SUCCESS STORIES DURING FISCAL YEAR 2017**



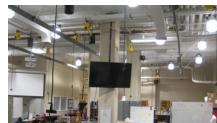
NC State avoided \$267,400 in utility costs during winter break. Since the Winter Holiday Energy Savings Initiative began in 2004, more than \$3.4 million in utility costs have been avoided.



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



Strategic classroom and HVAC scheduling, known as the Summer Energy Savings Initiative, avoided \$123,400 in energy costs during summer academic sessions in 2016.



A College of Textiles teaching lab and Witherspoon Student Center restrooms received LED lighting upgrades to improve lighting quality while reducing energy use.



At Cates Utility Plant, the installation of a system of HEPA filters on the second of the two CTGs increased electrical output and resulted in a simple payback of less than two months.

View the Annual Energy and Water Report online  
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