NC STATE UNIVERSITY


# ENERGY AND WATER ANNUAL REPORT

FISCAL YEAR 2024

# EXECUTIVE SUMMARY

The mission of NC State Energy Management is to optimize energy and water use across the campus to create a sustainable, efficient and cost-effective environment. The department achieves this by implementing innovative strategies guided by the Strategic Energy Management Plan (SEMP), focusing on reducing energy consumption, enhancing efficiency and meeting legislative mandates. Through advanced data management, supply optimization, conservation, equipment efficiency and campus-wide sustainability initiatives, the department fosters collaboration with students, faculty, staff and community partners to drive impactful programs like the “Sustain Our Pack” campaign and numerous applied learning projects for students, positioning NC State as a leader in energy efficiency and environmental stewardship.

The 2024 Energy and Water Annual Report highlights the university’s progress in advancing sustainability and reducing utility consumption across the Raleigh campus from July 1, 2023, through June 30, 2024. This year’s report not only measures reductions in energy and water usage, but also places these achievements within the broader context of the university’s long-term goals to improve efficiency, lower operating costs and reduce environmental impact.

In addition to performance data, the report outlines current actions guiding campus energy and water management, as well as the range of projects supporting these efforts. This includes initiatives in early planning with funding requests under consideration, projects that have secured funding and are progressing through design or construction and those that reached completion during the reporting period.

Finally, the report summarizes key renewable energy projects that are expanding the university’s portfolio of on-campus energy generation. These initiatives are integral to reducing the campus carbon footprint and strengthening resilience, ensuring that NC State continues to lead by example in sustainable resource management.

# HIGHLIGHTS IN FY 2024

**UTILITY REDUCTIONS:**

- Achieved a 34% reduction in campus energy use intensity (EUI) compared to the FY 2003 baseline, despite a 55% increase in campus square footage.
- Reduced total campus water (potable + reuse) consumption by 52% and potable water consumption by 60% compared to the FY 2002 baseline.

**COGENERATION AND EFFICIENCY:**

- Two cogeneration plants supplied nearly 50% of the university's annual electricity needs, avoiding millions in purchased electricity costs.
- Four active Energy Performance Contracts (EPCs) delivered over $21 million in annual utility savings. Advanced planning for Phase 5 began.

**KEY STRATEGIES IMPLEMENTED:**

- Expanded Ongoing Commissioning through development of a Building Automation System (BAS) Re-tuning process, identifying low-cost improvements to optimize energy use in campus buildings.
- Launched the Sustainable Labs Program with 11 laboratories certified for reducing energy and resource use.
- Completed advanced planning to execute the ECO-Mode initiative, which targets energy-intensive laboratories through smarter HVAC scheduling, reduction of overventilation and continuous commissioning.

**RENEWABLE ENERGY EXPANSION:**

- Completed construction on the largest solar project on campus to date: a 154kW rooftop array on Fitts-Woolard Hall, paired with a 250kW/430kWh battery system for peak demand reduction.
- Advanced planning for a 1.06 MW solar array at Varsity Parking Lot, expanding the university's renewable portfolio and capacity for on-campus energy generation.

**WATER CONSERVATION SUCCESS:**

- Expanded use of City of Raleigh reuse water for cooling towers, irrigation and toilet flushing, which reduces potable water demand and enhances resiliency during drought conditions.

**FUTURE OUTLOOK:**

- Continued investment in the AVEVA PI System, providing real-time energy monitoring and analytics to support decision-making, stakeholder engagement and long-term sustainability.
- Initiated evaluation of Low-Temperature Hot Water (LTHW) systems and large-scale heat pump integration to decarbonize heating infrastructure and boost energy efficiency.

# GOALS

NC State University has committed to the following goals related to energy, water and emissions reduction. These goals provide a direction and target for all energy and water conservation efforts. They also provide a benchmark against which progress can be measured.

**GOAL 1:** Reduce total campus energy use intensity (EUI) by 40% from the FY 2003 baseline.

**GOAL 2:** Expand the amount of renewable energy used to meet NC State's needs.

**GOAL 3:** Reduce campus water consumption by 65% from the FY 2002 baseline.

**GOAL 4:** Contribute to NC State's total greenhouse gas (GHG) emissions reduction by 25% from the FY 2008 baseline.

**GOAL 5:** Collaborate to inform and empower the campus community for energy and water savings.

# KEY PERFORMANCE INDICATORS

The table below shows progress toward NC State's 40% energy and 65% water reduction goals. NC State tracks year-over-year change as well as change vs. baseline years of 2002/2003. Overall FY 2024 performance vs. baseline shows a 34% decrease in Energy Use Intensity (EUI) and a 52% reduction in total water use per gross square foot on campus. Potable water consumption has decreased by 60%. These reductions have occurred despite a 55% increase in campus gross square footage since FY 2003. This means that although a significant number of new buildings have been added, total campus energy consumption per square foot has still decreased by more than one-third.

The cost of water has increased 110% since the FY 2002 baseline, but potable water usage has decreased by 60% which helps offset the rising cost. In addition, the number of heating or cooling degree days reflects the amount of energy needed to heat or cool a building to a comfortable temperature, given how cold or hot it is outside. Compared to FY 2023, the FY 2024 winter was colder, but the summer was milder.

| FISCAL YEAR | FY02* | FY03 | FY22 | FY23 | FY24 | % CHANGE (1 Year vs FY23) | %CHANGE from Baseline |
|---|---|---|---|---|---|---|---|
| UTILITY COST, $ / GSF | | $ 1.98 | $ 1.93 | $ 1.89 | $ 1.91 | 1% | -4% |
| ENERGY COST, $ / GSF | | $ 1.87 | $ 1.70 | $ 1.66 | $ 1.67 | 1% | -11% |
| WATER COST, $ / GSF | $ 0.12 | $ 0.11 | $ 0.24 | $ 0.23 | $ 0.25 | 9% | 110% |
| ENERGY CONSUMPTION (BTU / GSF) | | 171,810 | 111,602 | 111,114 | 112,739 | 1.5% | -34% |
| POTABLE WATER CONSUMPTION (CCF / GSF) | 0.066 | 0.054 | 0.027 | 0.026 | 0.0266 | 2% | -60% |
| TOTAL WATER CONSUMPTION (CCF / GSF) | 0.066 | 0.054 | 0.033 | 0.030 | 0.0316 | 6% | -52% |
| CAMPUS AREA GROSS SQUARE FEET (GSF) | 9,796,638 | 9,910,619 | 15,316,354 | 15,293,378 | 15,388,215 | 0.6% | 55% |
| HEATING DEGREE DAYS | | 3,592 | 2,697 | 2,499 | 3,260 | 30.5% | -9% |
| COOLING DEGREE DAYS | | 1,656 | 2,013 | 1,850 | 1,511 | -18.3% | -9% |

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

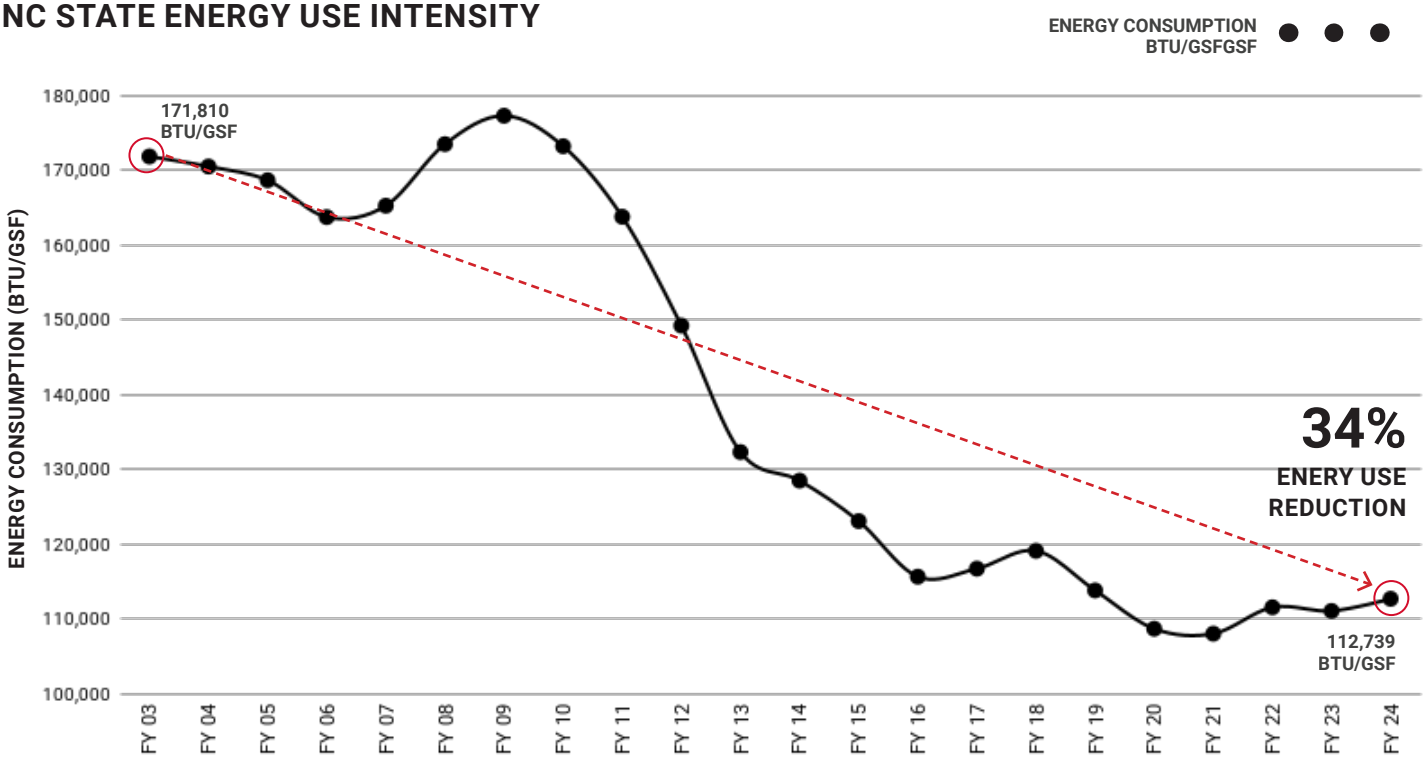
# CAMPUS ENERGY USE

NC State's energy use peaked in FY 2009 and has steadily declined since, following a 2007 state mandate to reduce energy in state-owned buildings. Early reductions came from large-scale lighting retrofits, HVAC upgrades, expanded building automation and systematic recommissioning. Additional decreases from 2012–2016 were driven by three major energy performance contracts.

Compared to the FY 2003 baseline, campus energy use per gross square foot (GSF) decreased by 34.4% in FY 2024, slightly below last year's 35.3% reduction. This dip is largely due to extended downtime of combined heat and power units (70 days beyond normal maintenance) and a slowdown in energy efficiency projects caused by funding gaps, contractual delays and reduced recommissioning staff. Without the excess cogeneration downtime, reductions would have reached 35.9%, surpassing last year's performance. These projects will be prioritized in FY 2025 to maintain momentum.

Since 2003, campus square footage has grown by 55%, making further reductions increasingly challenging. Still, NC State has made significant progress through operational enhancements, facility upgrades and community engagement. Continued innovation, collaboration and strategic investment will be critical to achieving future energy goals.

## NC STATE ENERGY USE INTENSITY




### Combined Heat and Power (CHP) Adjustment Methodology

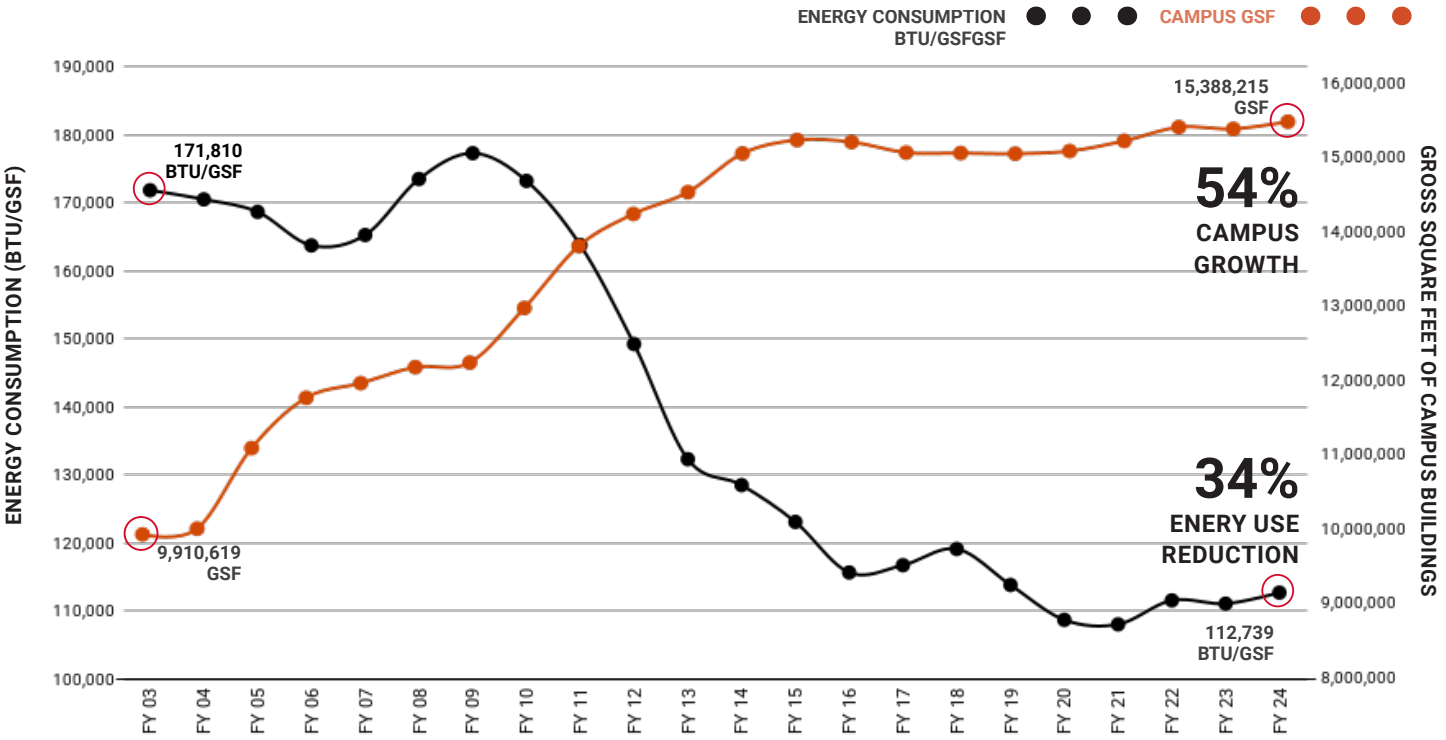
NC State purchases electricity, natural gas and fuel oil from third parties. Electricity is also generated by using an 11 megawatt (MW) CHP system on Main campus and a 5.6 MW CHP system on Centennial campus. As a result of CHP, purchased fuel use for on-site power generation increases, fuel use for boilers 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 2023. 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.

The university's growth versus Energy Use Intensity (EUI) over time is illustrated in the following chart, which indicates that although campus GSF has increased by 55% since the 2002/2003 baseline, EUI has decreased by 34%.

Maintaining and improving upon this EUI reduction will be a challenge over the next few years as the university faces both building growth and population growth. Several buildings are being renovated and a new integrative sciences building (Woodson Hall) is expected to open in FY 2027. While the new and updated buildings will be a benefit to campus, emphasis and focus are needed on energy conservation measures so that the campus EUI does not move in the wrong direction. All energy conservation measures will have to offset not only the preexisting utility load but also the load of these newly occupied buildings.

## NC STATE ENERGY USE INTENSITY AND CAMPUS GROWTH

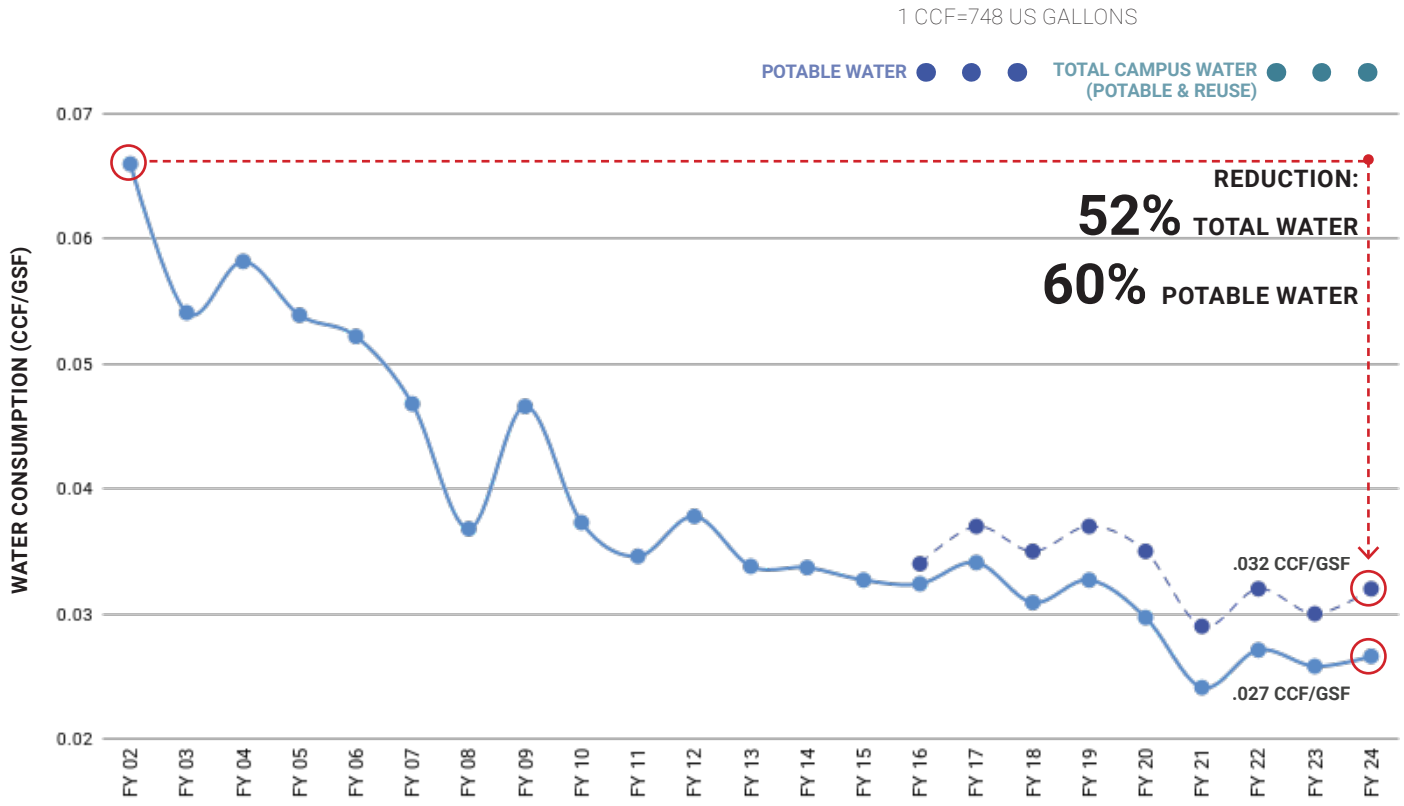



# CAMPUS WATER USE

In fiscal year 2016, NC State began utilizing non-potable reuse water supplied by the City of Raleigh on Centennial Campus. Reuse 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 utility plant cooling towers, campus irrigation and toilet flushing in certain campus buildings.

The following graph illustrates the university's total campus water consumption (potable and reuse) and potable consumption since the baseline year of FY 2002. For total water consumption (potable and reuse), FY 2024 marked a level 52% below the FY 2002 baseline with potable water consumption decreased by 60%. These percentages are slightly higher than the FY 2023 values of 55% and 61% respectively. About a quarter of this increase was due to more irrigation requirements because this was a dry year. Another half of the increase occurred due to major water line breaks and operational issues identified in the central utility plants.

## NC STATE TOTAL WATER CONSUMPTION: POTABLE AND REUSE (CCF/GSF)



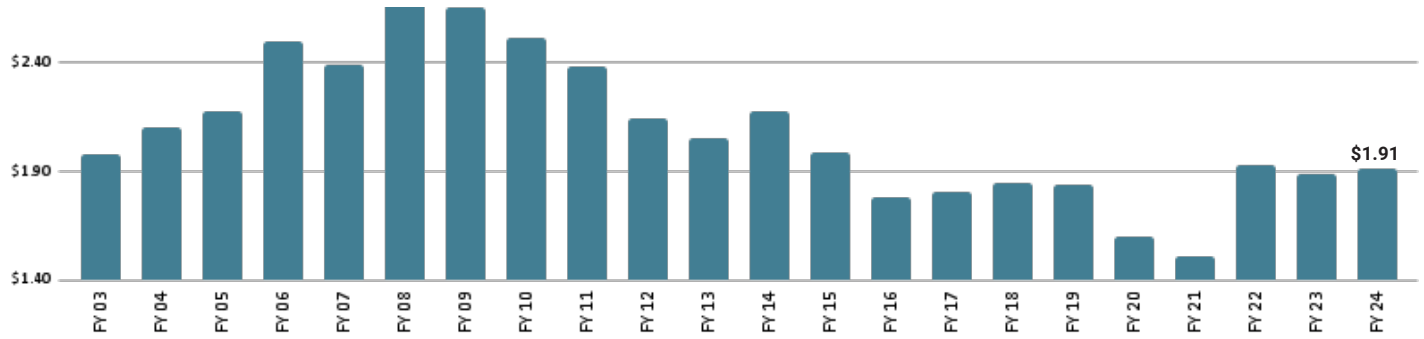

### Why does reuse water increase total water consumption?

Reuse water is less expensive and more sustainable than potable water because it has received less processing and thus has less embedded energy in its production. Because of this, the Centennial Campus Utility Plant cooling towers primarily use reuse water. Cooling towers work by evaporating heat from water to the outdoor air. As water evaporates, impurities in the water build up and require that the water be replaced periodically. Because reuse water has more impurities than potable water, it must be replaced more frequently. However, the benefits of reuse water – primarily the decreased costs and embedded energy savings – outweigh the additional water use.

# UTILITY COSTS

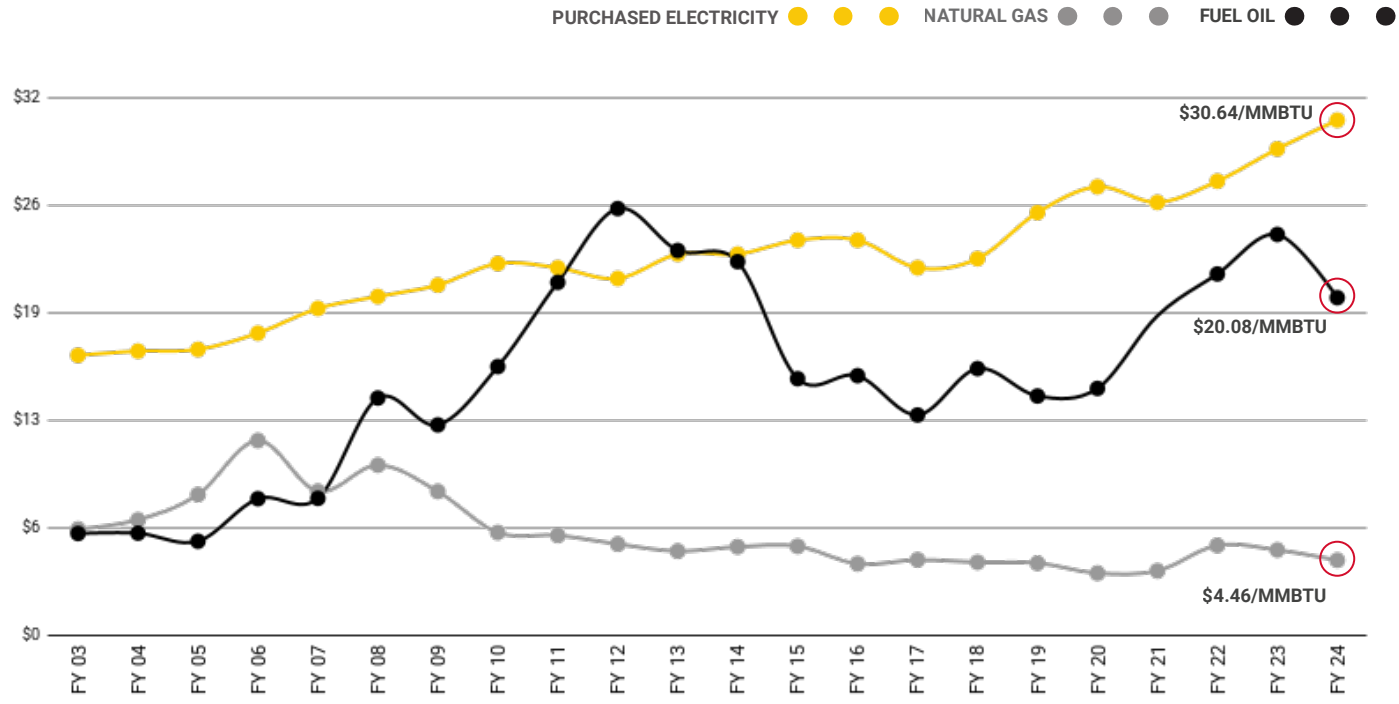
NC State spent over $29 million on total utilities during FY 2024. The overall utility costs per gross square foot (GSF) experienced a very slight increase, from $1.89 in FY 2023 to $1.91 in FY 2024. The chart below illustrates the combined utility costs per GSF since the baseline years of 2002/2003, peaking in 2008/2009 alongside campus energy usage.

## UTILITY COSTS PER GROSS SQUARE FOOT (GSF)



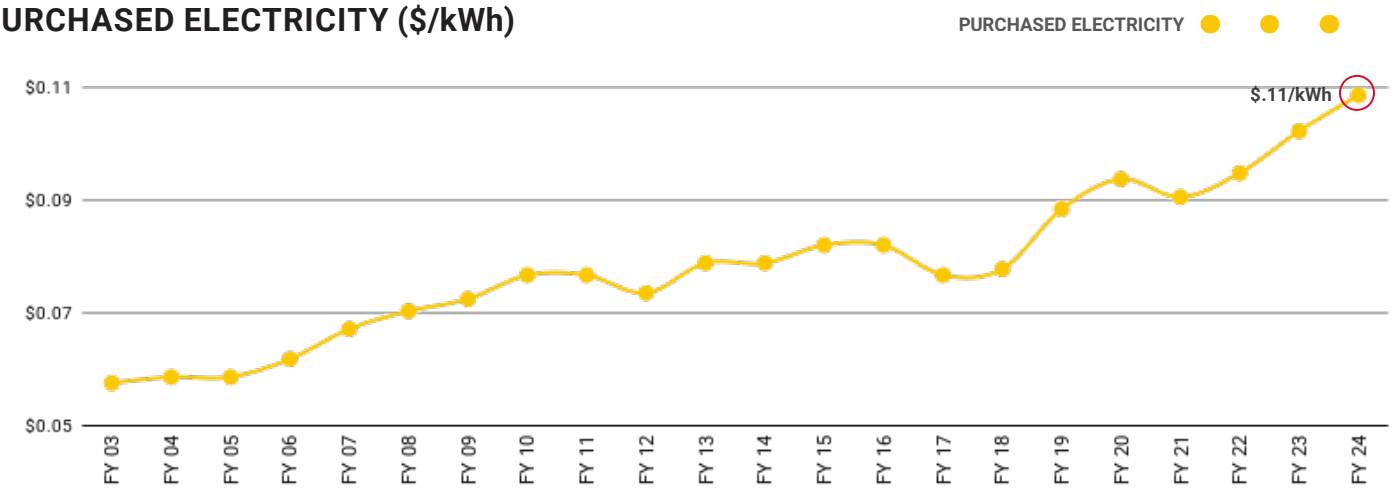

The following chart shows the average annual energy price for purchased electricity, natural gas and fuel oil on a dollar per MMBTU basis in order to show the relative cost of each utility per unit of energy provided. Electricity has the highest cost per MMBTU and the price of electricity has consistently risen over time. Fuel oil, which follows the market prices of oil, has shown a much more volatile price history. Natural gas prices have shown the lowest and most stable pricing of all of NC State's utilities. The campus has been insulated somewhat from the effects of volatile natural gas pricing on the open market by the hedging of natural gas purchases. Cogeneration of steam and electricity along with thermal energy storage also help to insulate the campus from the effects of rising energy costs. Energy Management avoided an additional one cent per square foot in total campus utility costs in FY 2024 by requesting a change in the electric rate schedule used to bill the main campus substation.

## AVERAGE ENERGY PRICES ($/MMBTU)

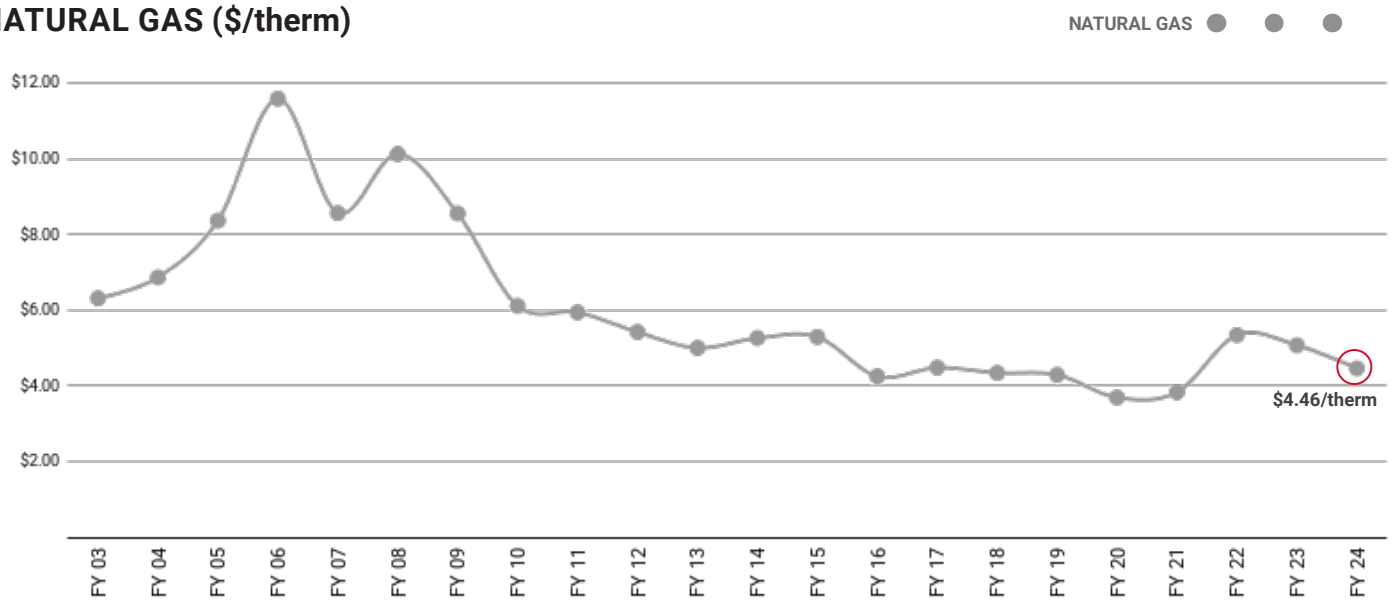


The charts below provide a breakdown of the cost of each utility per billable unit. This shows how the cost of utilities have diverged and changed over time. More specifically, electricity prices increased by 5.9% from FY 2023. Natural gas prices dropped 12.2%, fuel oil costs decreased by 15.8% per gallon and potable water/sewer went up by 3.7%. Reuse water also increased by 3.1%.

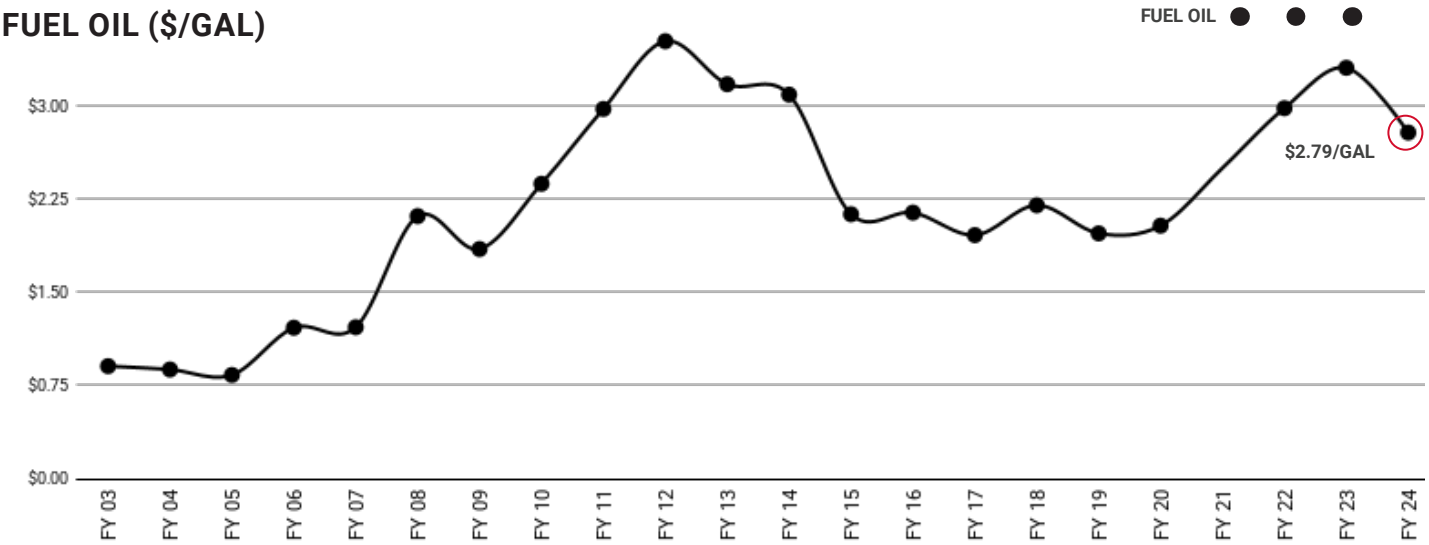
## PURCHASED ELECTRICITY ($/kWh)



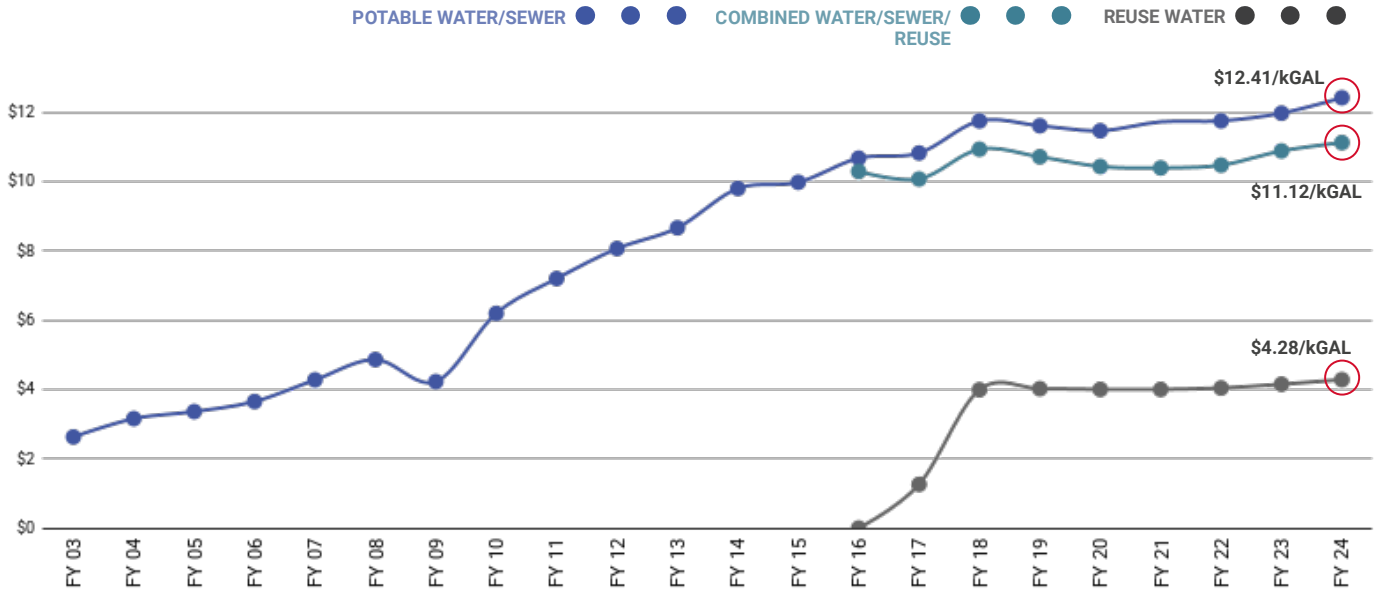

## NATURAL GAS ($/therm)




## FUEL OIL ($/GAL)



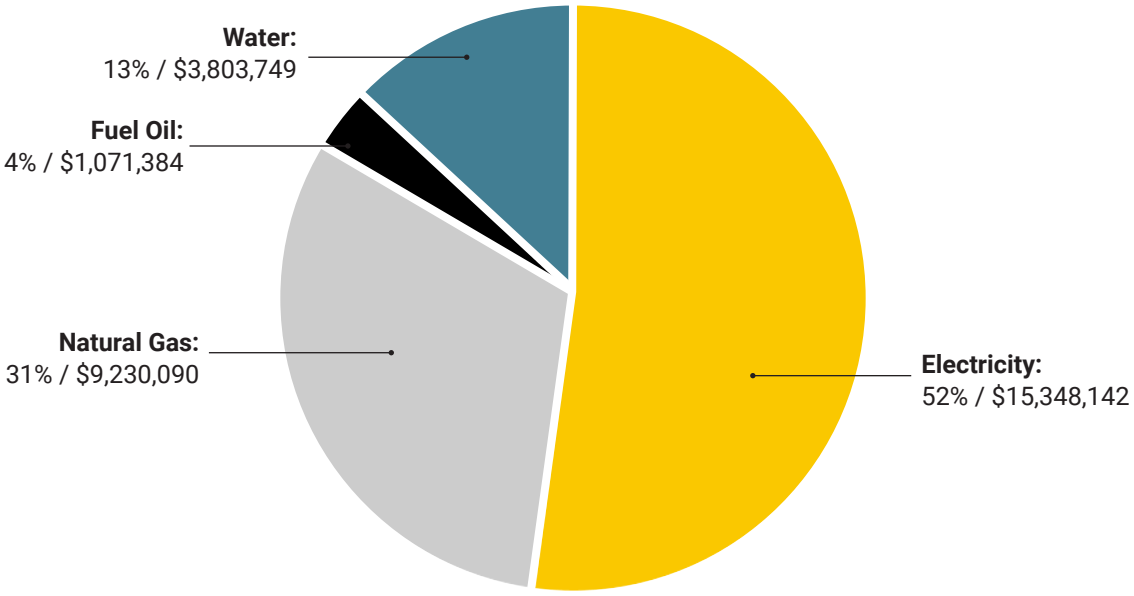
## WATER PRICES ($/kGAL)




Electricity is the largest component of purchased utilities at a cost of $15,348,142 for FY 2024. Electricity is also the utility most influenced by the campus community and, as such, has the greatest potential for reduction through conservation actions by individuals, 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. These efforts require a change in mindset and behaviors among the campus community.

Natural gas is the primary fuel used for on-campus generation of steam and electricity. When unavailable, either through equipment failure or natural gas curtailment (when the local natural gas distributor shuts off the campus gas supply due to unexpectedly high system demand), campus energy costs see a significant cost increase due to fuel oil costing more than natural gas. In FY 2024, fuel oil accounted for 2% of the energy used on campus, but due to a high price, fuel oil accounted for 4% of all utility costs.

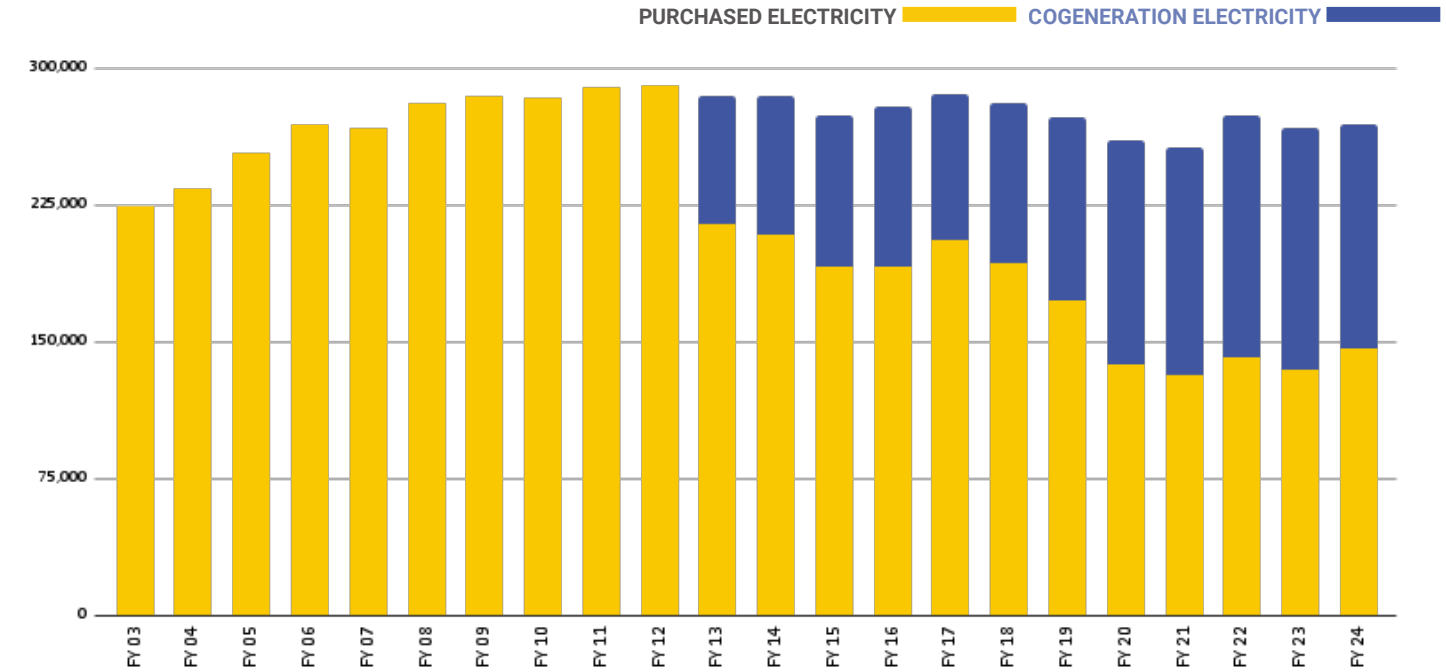
## ENERGY AND WATER EXPENSES



Cogeneration of steam and electricity is a powerful tool that NC State uses to reduce electricity purchases. The campus has a total of 16.6 MW of cogeneration (also called combined heat and power) on the main and Centennial campuses. When these systems are operating optimally, NC State is capable of generating approximately half of the electricity consumed on campus.

The graph below shows historical NC State electricity consumption with purchased electricity shown in yellow and the cogeneration contribution shown in blue. Installed in 2012, the first cogeneration installation contributed over 70,000 MWh of energy during the first year of operation. With the addition of cogeneration on Centennial campus in 2019, purchased electricity was reduced by almost an additional 20%. However, during FY 2024, NC State's reliance on purchased electricity actually increased by 6% from the previous year due to extended downtime with the cogeneration units.

## PURCHASED vs. CoGEN ELECTRICITY (MWh)




The Cates Avenue Utility Plant is one of five campus central utility plants and supplies buildings on Central and North campuses at NC State.

Energy Management's chief effort towards the 40% energy reduction goal is through energy conservation projects, including:

| FISCAL YEAR 2024 ENERGY PROJECTS | STATUS | BUDGET | FUNDING SOURCE | ESTIMATED ANNUAL SAVINGS | SIMPLE PAYBACK (YEARS) |
|---|---|---|---|---|---|
| ULT Freezer Rebate Program | Ongoing | $ 50,000 | DSM/EE | $ 10,000 | 5 |
| Annual Steam Trap Survey | Ongoing | $ 2,500 | DSM/EE | $ 10,000 | .3 |
| Fume Hood Decommissioning Program | Ongoing | $ 15,000 | DSM/EE | $ 5,000 | 3 |
| Energy Risk Management Consultant | Ongoing | $ 40,200 | DSM/EE | NA | NA |
| Turlington & Alexander Residence Halls - Replace Mechanical Fan Coil Thermostat Controllers | Completed | $ 160,000 | DSM/EE | $ 31,500 | 5.1 |
| Engineering Building I - Recommissioning | Completed | $ 150,000 | DSM/EE | TBD | TBD |
| Monteith Research Center Supply Fans and Return Fan AHU VFDs Installation | In Planning | $ 100,000 | DSM/EE | $ 97,500 | 1 |
| Caldwell Hall Duct Sealing | In Planning | $ 12,682 | DSM/EE | $ 2,320 | 5.5 |
| Toxicology Lab Energy Reduction from Exhausts | In Planning | $ 361,250 | DSM/EE, F&A | $ 100,000 | 3.6 |
| Monteith Research Center - Building Retrocommissioning | In Planning | $ 165,000 | DSM/EE | TBD after RCx | TBD after RCx |
| LED Conversion - Auto Shop | In Planning | $ 4,727 | DSM/EE | $ 963 | 4.9 |
| Nelson Hall - HVAC Controls Upgrade | In Progress | $ 758,156 | HB1292 | TBD | TBD |
| University Communications - Energy Outreach/ Communication Strategy Development | In Progress | $ 25,000 | F&A | NA | NA |
| Professional Study and testing of potential eDNA replacement | In Progress | $ 50,000 | F&A | NA | NA |
| Advanced Planning/Design Sullivan Shops Solar PV | In Progress | $ 40,000 | F&A | NA | NA |
| Advanced Planning/Phased Design Varsity Lot Solar PV | In Progress | $ 50,000 | F&A | NA | NA |
| Page Hall Mechanical & Electrical Upgrade | In Progress | $ 468,948 | HB1292 | NA | NA |
| Fitts-Woolard Hall Solar Photovoltaic Array | In Progress | $ 509,625 | HB1292 | $ 23,800 | 21.4 |
| Battery Storage - Centennial Campus Infrastructure | In Progress | $ 500,000 | HB1292 | $ 85,400 | 5.6 |
| LED Conversion - CVM Main | In Progress | $ 740,000 | HB1292 | $ 220,000 | 3.4 |
| LED Conversion - Williams Hall | In Progress | $ 360,000 | HB1292 | $ 96,000 | 3.8 |
| LED Conversions (Exterior Lighting) - South & Centennial Campuses | In Progress | $ 889,880 | HB1292 | $ 277,700 | 3.2 |
| Controls Upgrades - MRC & PSC | In Progress | $ 338,731 | HB1292 | TBD after RCx | TBD after RCx |
| Schaub Food Science Building Phase II Ventilation Study & Implementation | In Progress | $ 43,500 | F&A | $ 108,900 | 0.4 |
| Mary Anne Fox Phase II Ventilation Study & Implementation | In Progress | $ 40,000 | F&A | $ 42,420 | 1 |
| Schaub Food Science Building Steam Trap Replacements | In Progress | $ 10,000 | F&A | $ 40,000 | 0.3 |
| Schaub Food Science Building Energy Improvements Phase I - Resolve RCx Findings | In Progress | $ 36,500 | F&A | $ 30,000 | 1.2 |
| Meter Upgrades - Multiple Buildings Implementation | In Progress | $ 57,500 | F&A | NA | NA |

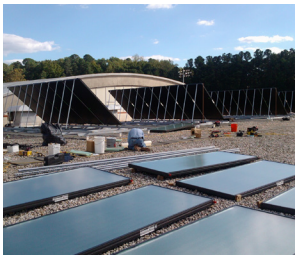
# ENERGY PERFORMANCE CONTRACTS

NC State utilizes energy performance contracting (EPC) to upgrade facilities and systems, avoid operational expenses and reduce emissions.  The university currently has four EPCs.

## COGENERATION ON CENTRAL AND NORTH CAMPUS (2012)

17-year contract, $56.1 million investment

In 2012, this project replaced aging boilers in the  Yarbrough Central Utility Plant with new high efficiency boilers and installed two combined heat and power cogeneration systems at the Cates Utility Plant. The cogeneration system utilizes natural gas to produce 11 MW 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. These systems also allow NC State is to produce almost 50% of the electricity needed annually. The most recent annual savings for this performance contract was over $8.9 million.



## 13 BUILDING EPC  (2012)

19-year contract, $19.7 million investment

This project installed renovations and operational improvements with HVAC system and fume hood controls, lighting upgrades and water conservation strategies in a total of 13 buildings across the campus. These buildings were: Cox Hall, Poe Hall, Tompkins Hall, Caldwell Hall, Winston Hall, Wilson College of Textiles, McKimmon Center, Monteith Research Center, Research I, Dabney Hall, Carmichael Gym, Constructed Facilities Lab and MRC Parking Garage. The most recent annual savings for this performance contract exceeded $2 million.

## PHYTOTRON BUILDING EPC (2014)

15-year contract, $6.2 million investment

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, a connection to the central chilled water loop and research equipment improvements. Phytotron's most recent annual savings for this performance contract exceeded $800,000.

## CENTENNIAL CAMPUS COGENERATION EPC (2019)

18-year contract, $17 million investment

This project removed a boiler in the Centennial Central Utility Plant and installed a high efficiency cogeneration system. The cogeneration system includes a combustion turbine generator (CTG) which generates 5.6 MW of electricity, and a steam turbine generator (STG) which is capable of generating an additional 1 MW of electricity from the excess steam.  Utility savings are realized due to a reduction in the total cost of electricity and steam production through increased efficiency. The most recent annual savings for this project exceeded $1.5 million.

# RENEWABLE ENERGY

A renewable energy portfolio is a strategic tactic to advance NC State's emissions reduction goals. The university is actively exploring, planning and capitalizing on incentives for integrating renewable energy technologies. These efforts will boost renewable generation and deploy energy storage. The following projects represent the initial phase of these technologies entering campus:

**Fitts-Woolard Hall Solar Array:**
A 154kW/DC ballasted rooftop solar array on Fitts-Woolard Hall was completed in 2024. This installation is the largest solar project on campus to date. This system will directly connect to the building, reducing reliance on purchased electricity for building operations. Energy Management is monitoring real-time data on system performance.

**Centennial Battery Storage:**
Outside of Partners I, a 250kW battery was being installed to support the solar PV system on the roof of Fitts-Woolard Hall. Energy will be stored in the batteries and discharged during peak times in order to reduce the cost of purchased electricity.

**Future Projects - Varsity Lot Solar PhotoVoltaics:**
Energy Management is in the planning phase for solar arrays at the Varsity Parking Lot, which already has buried electrical infrastructure in place to enable production of up to 1.06 MW/AC of electricity. This project is still in the advanced planning phase.

**Sustainability:**
The University Sustainability Office supports Energy Management's goals by providing data tracking, outreach and communication efforts. This includes maintaining NC State's Greenhouse Gas Inventory, which shows a 27 % reduction in Scope 1 and 2 greenhouse gas emissions on campus from FY 2008 to FY 2024. The Sustainability Office also maintains an online and interactive campus sustainability map featuring high performance buildings, renewable energy infrastructure and other features.

The 2024 Energy and Water Annual Report
is produced by NC State Energy Management.

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