Duke | Facilities Management
Utilities & Engineering Services

FMD Energy Summary & Major Initiatives Update

February 2016

Table of Contents

Executive Summary

- Energy is a substantial, necessary asset that the Duke uses every day to support its mission. The goals set forth in the Climate Action Plan guide that asset management.
- Energy-efficiency projects have realized emissions reductions of over 49,000 MTCO2/yr since tracking formally began, just for the University & SOM facilities.
- Since 2007, Duke has reduced its energy-related emissions by 33% (from 264,194 MTCO2e to 177,112 MTCO2e), even as campus has grown by over 2M square feet.
- Since the 2008 baseline data year, the existing buildings under CAP purview (University, SOM, SON) have reduced energy consumption by 10%, ahead of pace to meet our goal of 15% reduction over a 20-year period.
- Since 2008, Duke campus as a whole (DU & DUMC) have reduced facility energy consumption by 15% on a per square foot basis.
- The elimination of coal in campus steam plants in 2011 is a significant, impactful action that demonstrates Duke's commitment to mitigating climate change. Combined with energy efficiency efforts, this change realized emissions reductions of 42,000 MTCO2e/yr.
- Though not part of CAP reporting, Duke considers water to be as important an asset as energy. The FY15 reporting year closed with Duke using 177 million gallons of water less than in 2007. On a per-square-foot basis, this represents a 40% reduction while campus has grown over 2.7M GSF
- The Duke Water Reclamation Pond is expected to recover over 100 million gallons of reclaimed water, that would otherwise come from potable municipal sources.
- Duke University has invested significantly in carbon-footprint reduction projects, both on-campus and off, and has made significant progress in achieving the goals set out by the Climate Action Plan.

Climate Action Plan Energy Goals

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

Push beyond the current LEED building policy to establish green building energy consumption standards and an approval protocol for building energy consumption review -- implement, measure and report on energy use targets by Building Tech Rating

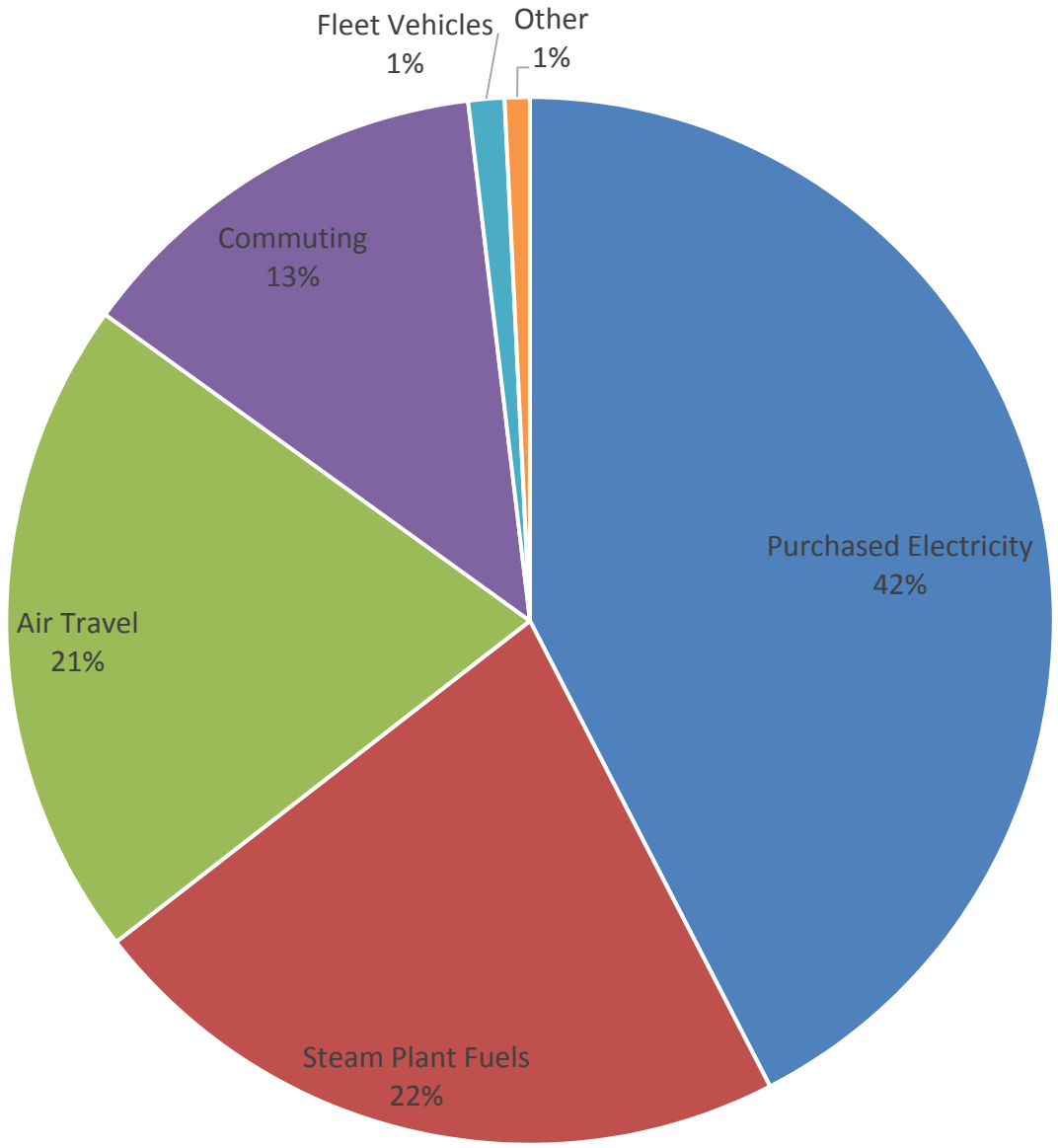
Beginning in 2010, implement energy conservation measures (ECMs) in existing buildings with the goal to realize a 15% reduction in energy use over a 20 year period (2010 – 2030)

Continue to urge, monitor and review Duke Energy's progress towards emissions reductions while exploring on-campus electricity generation options. Additionally, Duke should install 4MW solar PV array by 2012

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

Leverage research into alternative technologies and explore and implement conversion to biogas, solar PV, solar thermal, combined heat and power or other technologies by 2030

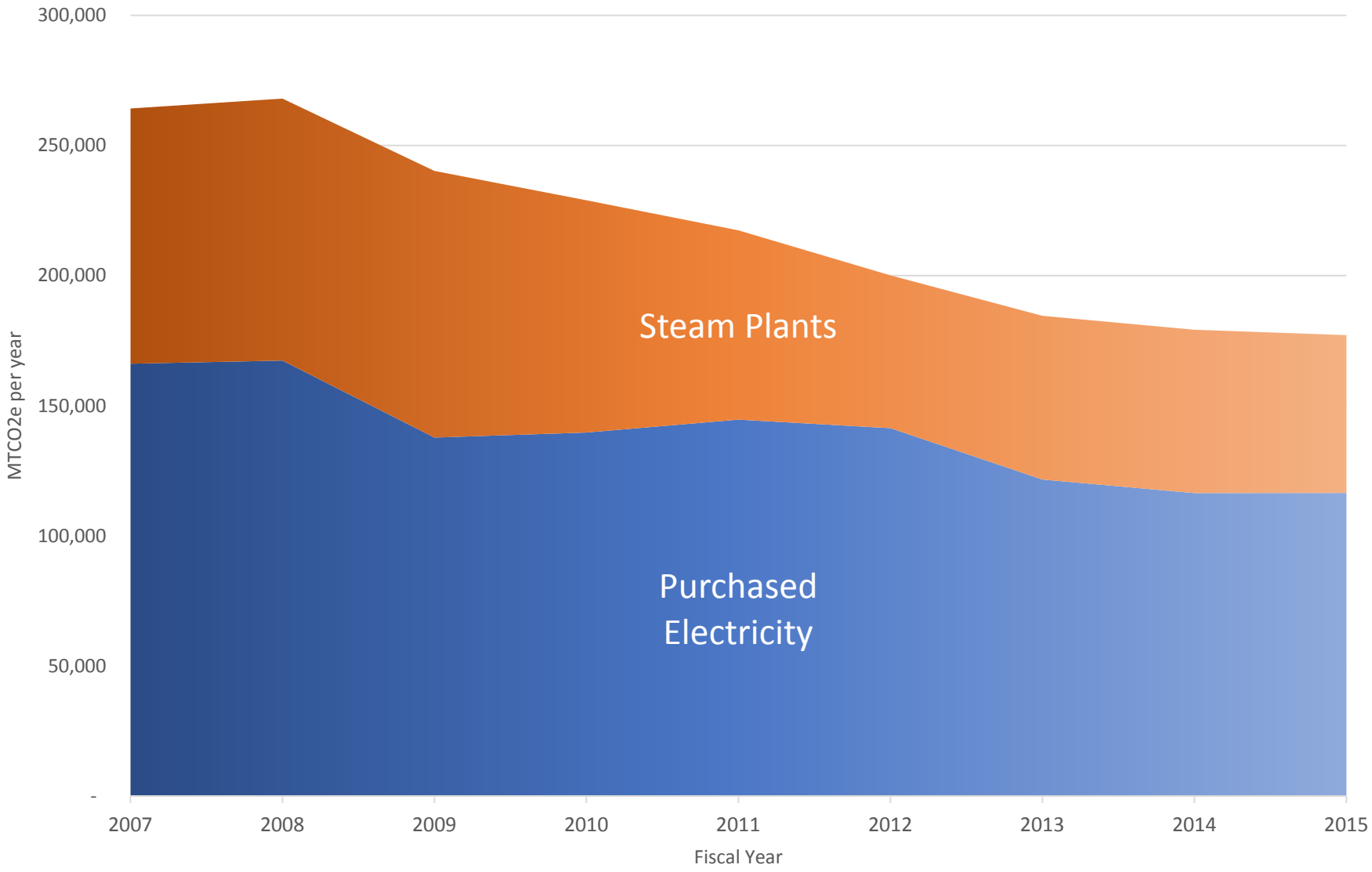
FY15 Greenhouse Gas Footprint Breakdown



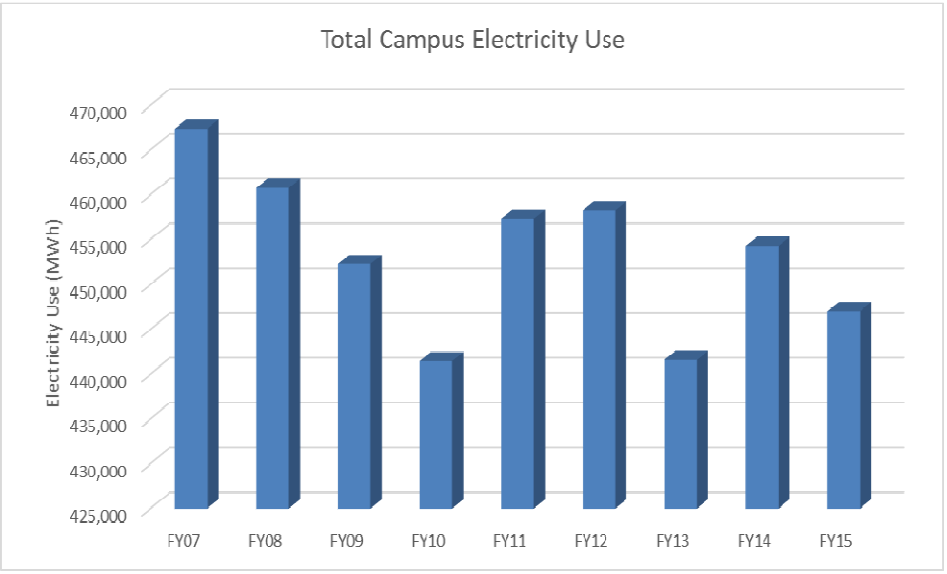
Current FY15 GHG footprint:
274,594 MTCO2e

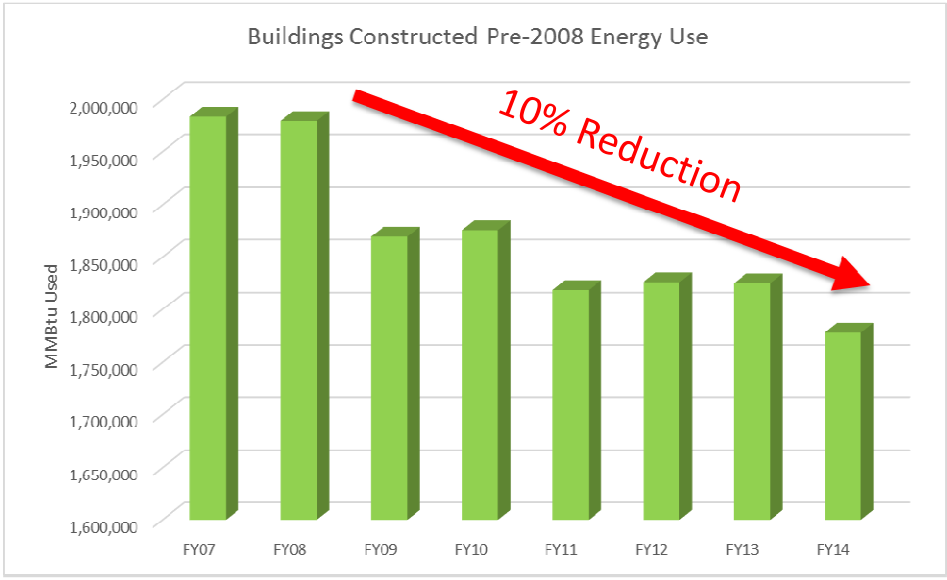
2024 CAP GHG target:
197,543 MTCO2e

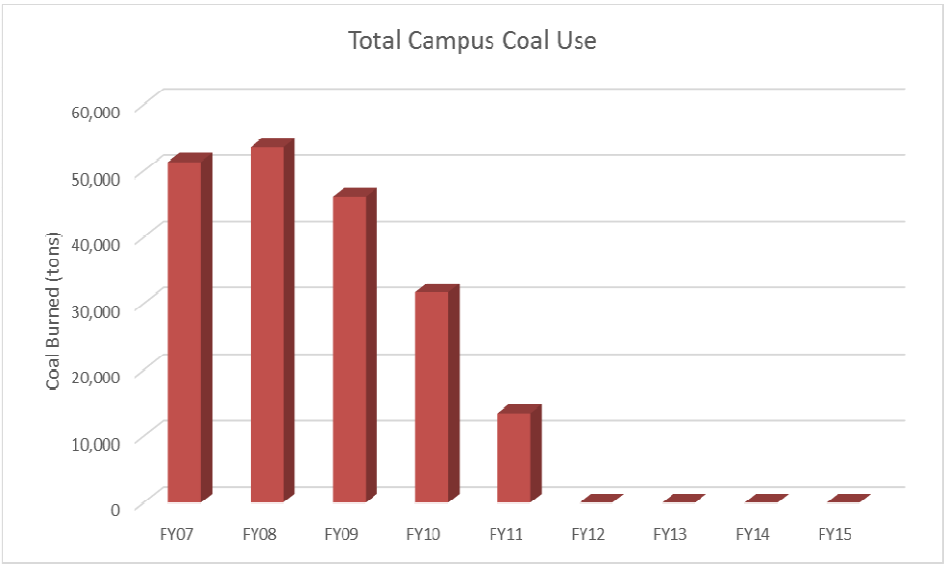
FY15 Building Energy-Related Emissions

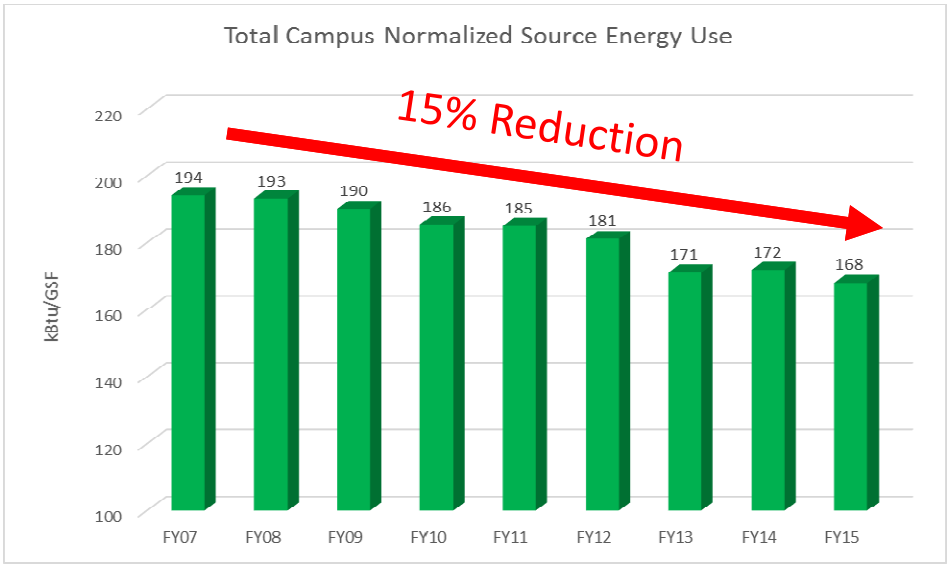


Campus Energy Use – Continued Efficiency Improvement









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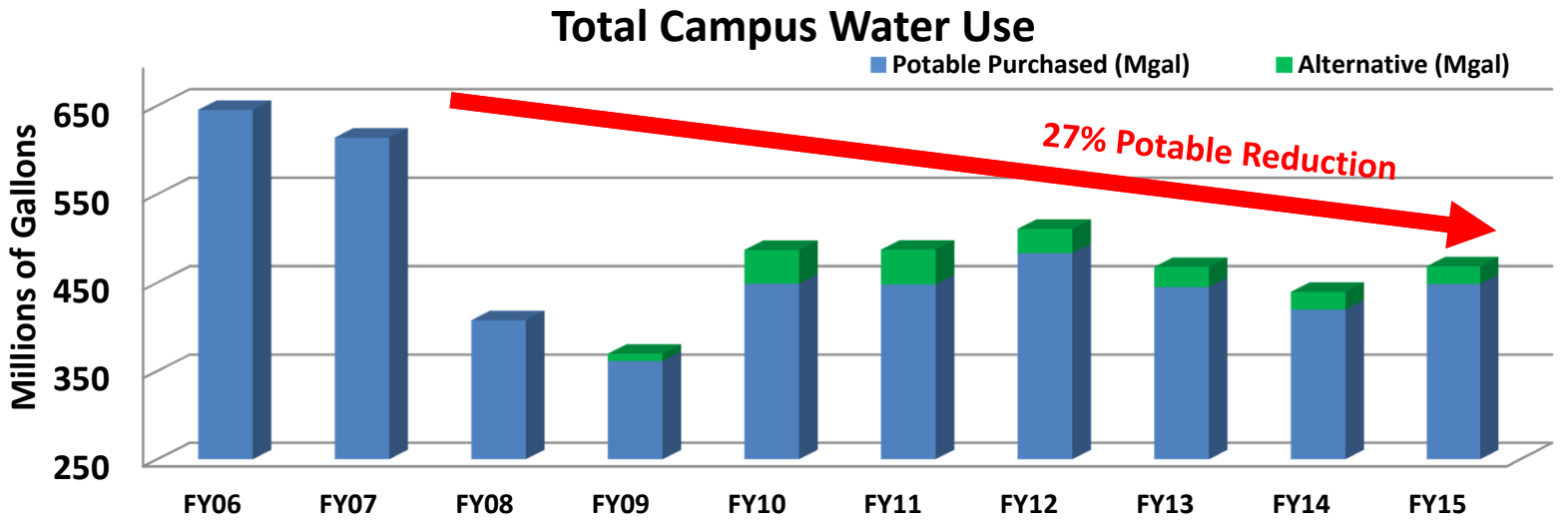
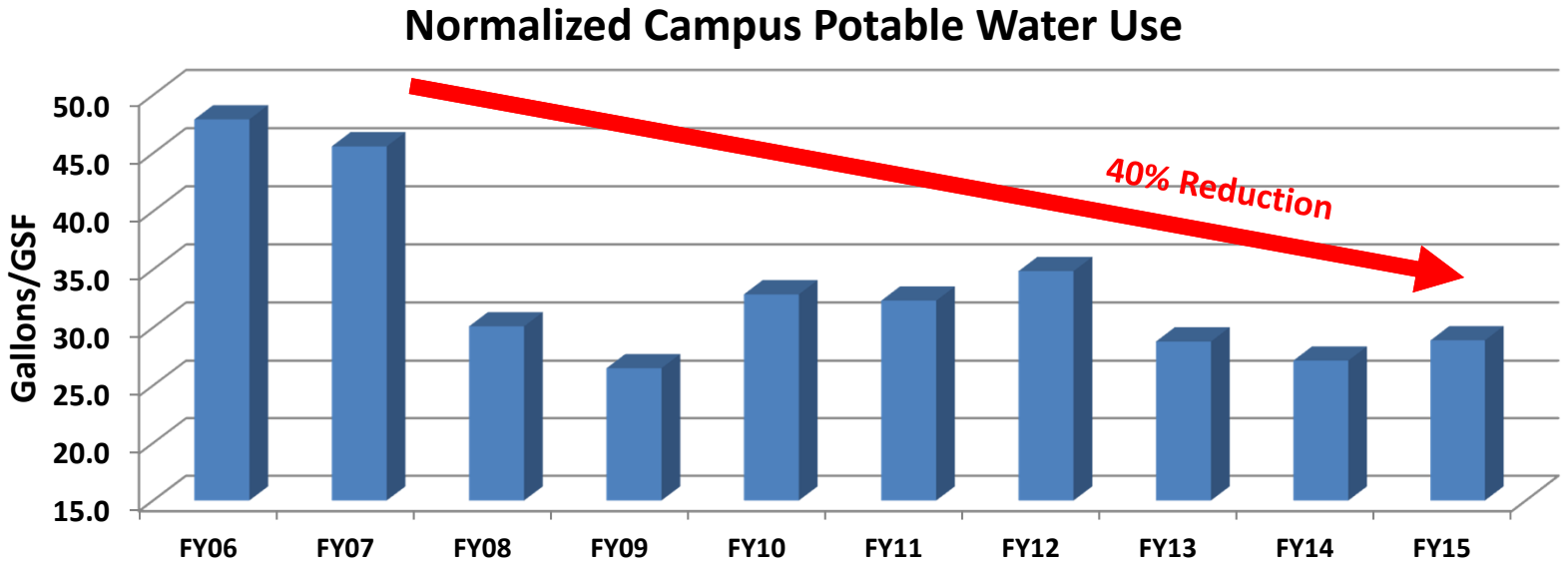
Approximately 2.7M GSF increase in built environment from 2007-2015

Energy Projects Completed or In Progress

Description	Year	Type	Summary	Status
Bryan Center Solar Thermal	2008	Renewables - Solar Thermal	Purchasing heat for domestic hot water from 100,000 MBH solar thermal rooftop system. Demonstration project - solar thermal heat cost is above cost of district heat. University will take ownership in approx. 18 months. Equipment has been problematic since installation with frequent service interruptions.	Complete - in service
East Campus Steam Plant Fuel Conversion	2009	Fuel Switch	Boiler replacement and re-commissioning of East Campus Steam Plant as natural gas burning heating plant. This project allowed uninterrupted campus operation while West Campus Steam plant was converted from coal to natural gas.	Complete - in service
Chilled Water Plant 2 Variable Frequency Drives	2010	District Energy Efficiency	Installed two variable-speed chillers with CWP2 expansion, allowing up to 70% efficiency increase for these units during non-peak cooling hours	Complete - in service
Lloyd Ray Farm Waste-to Energy	2011	Renewables - biogas	Hog waste in Wilkes County recapturing hog waste methane for power generation. Demonstration project in support of Hog Waste carve-out in NC REPS requirements, executed by DCOI.	complete - in service
West Campus Steam Plant Fuel Conversion	2011	Fuel Switch	Boiler and major equipment replacements to convert West Campus Steam Plant from coal to natural gas fuel, reducing Duke's carbon footprint by 38%	Complete - in service
West Campus Steam Plant Condensing Economizer	2011	District Energy Efficiency	Installed flue-gas heat recovery system to increase steam plant efficiency by approximately 10%. Equipment is saving average of 4 million Btu/month, over $250k/yr	Complete - in service
Environment Hall PV	2013	Renewables - PV	45 kW(dc) rooftop PV system installed as part of Environment Hall construction. Demonstration project - exceedingly high installed cost ($6.20/W) for scalability	Complete - in service
Environment Hall Solar Thermal	2013	Renewables - solar thermal	50,000 Btu/hr solar thermal system installed as part of Environment Hall construction, providing domestic hot water to sinks for handwashing. System has operated as intended.	Complete - in service
DU Marine Lab	2012 - 2015	Building Energy Efficiency - Geothermal	Two Duke University Marine Lab facilities utilize geothermal equipment for building HVAC, with energy efficiency gains of 25% over traditional air-cooled equipment	Complete - in service
District Hot Water Conversion	2016	District energy efficiency	Buildings are being converted from steam to district hot water heating source. In addition to significant maintenance savings, overall energy efficiency gains are expected to be 4%, with 1-2% carbon footprint savings. Hot Water Plant #1 complete and operational, with 10-year building connection plan in progress.	Complete - in service

Campus Water Use – Continued Efficiency Improvement





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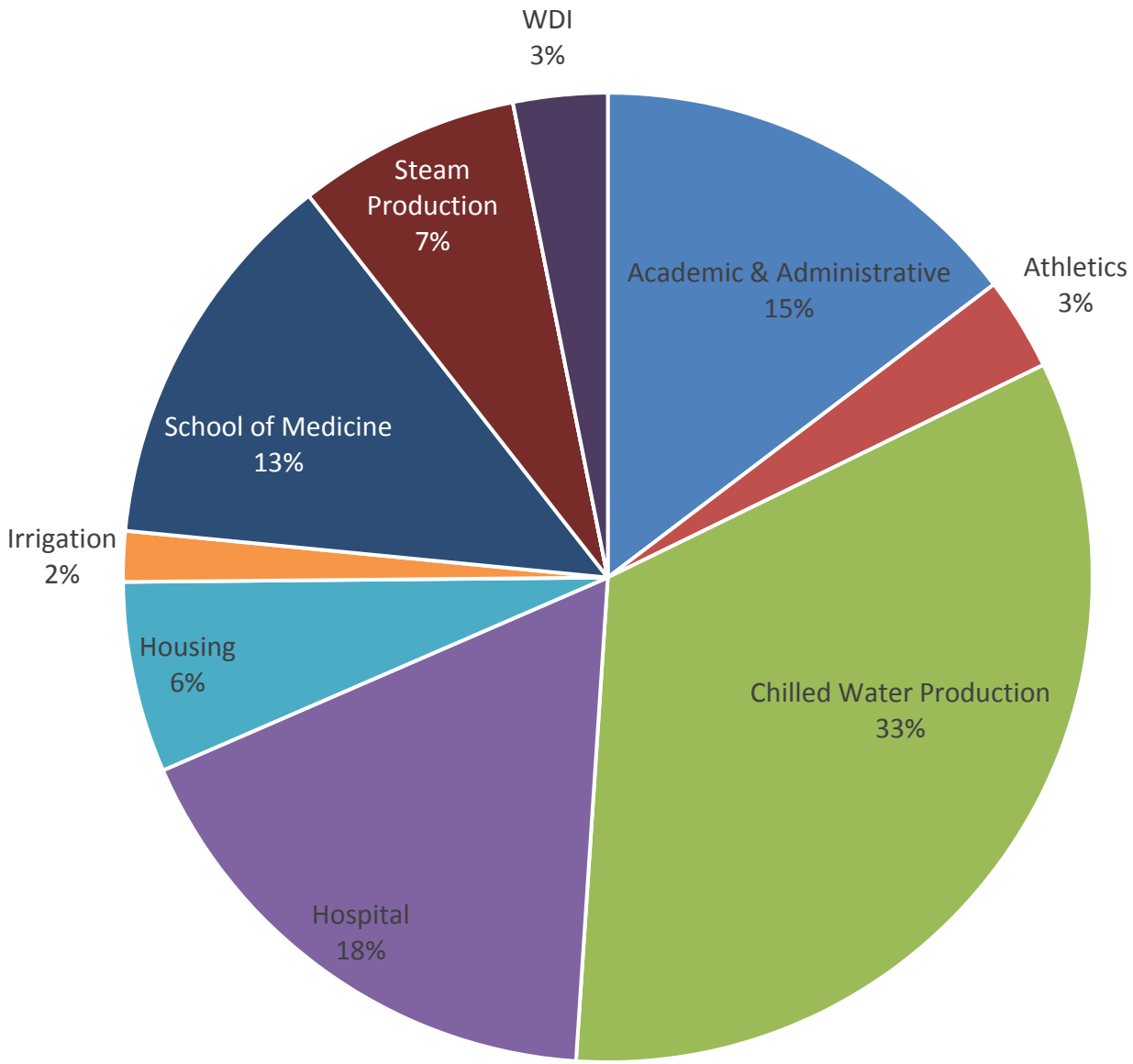
Approximately 2.7M GSF increase in built environment from 2007-2015

FY15 Potable Water Consumption Breakdown by Use



Water Projects Completed or In Progress

Description	Year	Type	Summary	Status
District Chilled Water System Development	2000 - present	District Water Efficiency	Beginning in 2000 and continuing today, Duke continues to increase the number of buildings connected to the district chilled water system. This has allowed the removal of individual building-level cooling towers, improving water use efficiency by	Complete - in service
Campus-Wide Water Audit	2007 - 2008	Study	In response to historic drought conditions in the Southeastern US, Duke performed a campus wide water audit to identify opportunities and develop an overall strategy for reducing potable water consumption.	Complete - in service
Low-Flow Showerhead Giveaway	2008-2009	Community Engagement	Duke FMD provided low-flow showerheads to any member of the campus community who wanted one. Recipients were asked to install in their own place of residence to help ease the demand burden on the Durham's municipal water system	Complete - in service
Water Metering Upgrades	2010 - present	District Water Efficiency	In 2010 Duke began upgrading existing water meters and installing more water meters at the building level to provide more granular data and identify water savings opportunities	Complete – in service
Air Handler Condensate Recovery	2009	District Water efficiency	All buildings requiring high volumes of outdoor air/ventilation (typically labs, research environments) are connected to the district condensate recovery piping system. This system recovers 9-10M gallons/yr of water that is condensed out of the air during the conditioning process	Complete - in service
Building Water Efficiency Improvements – Phase 1	2012 - 2013	Building Water Efficiency	Audited water use in top 6 water using buildings on campus. Installed low-flow toilet, urinal, lavatory, and shower hardware and realized ~12M gallons/year water savings	Complete - in service
Building Water Efficiency Improvements – Phase 2	2013 - 2014	Building Water Efficiency	Audited water use in athletic and recreation buildings. Installed low-flow toilet, urinal, lavatory, and shower hardware to realized ~3M gallons/year water savings	Complete - in service
Sustainable Building Guidelines	2015	Building Water Efficiency	In conjunction with other sustainable building efforts,, Duke developed a guideline requiring all new construction and major renovation projects to be designed to use at least 35% less potable water than baseline designs	Complete - in service
Building Water Efficiency Improvements – Phase 3	2015 - 2016	Building Water Efficiency	Audited the remaining of the top-50 water-using buildings on campus. Installing low flow hardware in 18 buildings in late FY15-early FY16, and expecting ~8M gallons/year water savings.	In Progress
Water Reclamation Pond	2016	District water efficiency	Developed 6-acre on-stream pond to manage both storm water runoff and to provide a non-potable water source for chilled water plant cooling towers. Total 10-acre site developed as an aesthetic and research amenity for campus. Expected to reduce potable water consumption by 100 million gallons per year	Complete - in service

Energy & Water Projects Studied or Being Studied

Description	Year	Type	Summary	Status
Parking Garage #9 Solar Lease	2009	Renewables - PV	Developed proposals for solar tax-flip lease-back PV installation. ~450kW system, Levelized Cost of Energy of 11-12¢/kWh, versus cost of grid energy at 6¢/kWh	Not pursued - Payback too high
Pascal Field House PV study	2010	Renewables - PV	Studied installation of PV system on roof of Pascal Field House. Cost estimates showed excessively high cost of installation & LCOE.	Not pursued - Payback too high
West Campus Steam Plant Fuel Conversion	2010	Fuel Switch	Study to evaluate feasibility of converting previous coal burning boilers at WCSP to coal gasification. Renewal and Operating costs of coal handling equipment significantly higher than natural gas option, with much less impactful carbon footprint reduction.	Not Pursued - carbon reduction not significant enough
West Campus Steam Plant fuel conversion	2010	Renewables - Biomass	Feasibility study for biomass fuel option for WCSP. Studies indicated need for 25-30 tractor trailer loads of woody biomass coming to campus per day, and approx. 3 acre material handling site. Lack of regional suppliers within 1 day delivery is major energy security risk, plus noise, traffic, and site area in the middle of campus were significant concerns.	Not Pursued - transport and energy security too risky
Duke Energy Green Source - Parking Garage #9 PV	2014	Renewables - PV	Proposals for University owned and developer-owned PV, ~700kW, both through Duke Energy GS program. Costs proposed at 13-19¢/kWh, more than triple the cost of grid-purchased power.	Not Pursued - Payback too high
Duke Energy Green Source - renewable PPA	2014	Renewables - Wind	Feasibility proposal to purchase wind-generated power from mid-west at 11-12 ¢/kWh. However, to qualify for GS rider, University needs to identify 1 MW new load coming online, which is difficult with our efficiency improvements.	Not Pursued – not qualified, payback too high, no local impact
Waste-to-Steam	2015	Renewables - waste fuel gasification	Feasibility study to gather municipal solid waste and regulated medical waste for pyrolisis/steam generation. Duke does not generate enough waste to be able to fully utilize this type of equipment. Site concerns for waste processing facility on campus were an issue.	Not Pursued - not enough solid waste available
Utility Scale PV	2016	Renewables - PV	Currently studying ground-mount PV options to develop economics, carbon reduction potential, utility interconnect requirements.	Study in Progress
Grey Water Reclamation	2016	District Water Efficiency	Currently studying feasibility of other grey water reclamation projects in order to find other alternative water sources for campus cooling plants in conjunction with research and educational opportunities	Study In Progress

Visualizing the Shrinking Carbon Footprint