Appalachian
STATE UNIVERSITY

2019 – 2020 Strategic Energy and Water Management Plan

Contents

Executive Summary

In her "Letter from the Chancellor," [1] from the 2025 Master Plan, Chancellor Everts stated "we develop our campus in ways that protect and broaden its beauty and live up to our core value of sustainability." Energy and water management is an important aspect of these Appalachian State University core beliefs.

The "2019-2020 Strategic Energy and Water Management Plan" outlines how we

- Align Appalachian State University with applicable NC statutes and UNC guidelines,
- Set our energy goals by linking our GHG (greenhouse gas) emissions and EUI (Energy Usage Intensity) responsibilities,
- Identify water use goals by referring to the University's 2025 Master Plan,
- Compare our actual progress towards meeting the energy and water consumption goals, and
- Mandate methods to meet our energy and water goals.

KPI's (Key Performance Indicators)[2]

In order to measure our progress towards meeting the UNC and State goals of Climate Neutrality by 2050, the following KPI's and their requirements for 2019-20 are:

1. *GHG (Green House Gas Emissions)*
   - Reduce facility GHG by 11.5% (from 42,036 to 37,185 $MTeCO_2$)
   - Maintain and improve fleet and vehicle GHG reductions (now 13% better than target)
2. *EUI and WUI (Energy Usage Intensity and Water Usage Intensity)*
   - Decrease the EUI by 19.9% to 78.3 kBTU/sq.ft. (from 494 to 424 Billion BTUs)
   - Reduce the WUI by 2.5% to 16.7gal/sq.ft.
3. *Energy and Water Expense*
   - Reduce energy and water costs by at least 2.5%

Guiding Principles and Documents

Controlling utility costs is critical to successful operations of an institution. By exceeding the requirements in SB668[3], Appalachian State has avoided spending over 37 million dollars[4], freeing that money for other purposes critical to our mission. Energy savings can also be used towards further energy savings projects when below energy budget;[5] Appalachian has received over $900k in funds that could be re-invested in ECMs.

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[1] "APPALACHIAN STATE UNIVERSITY MASTER PLAN 2025," page 4, version applicable in 2019- dated 2016 - 2017

[2] See Appendix on page 22

3 Senate Bill 668 "An Act to promote the conservation of energy and water use in state, university, and community college buildings," NC General Assembly, Session 2007.

4 Utility Savings Report, 2018-19, Appalachian State University: $30M in energy costs and $7.0M in water and sewer costs

5 House Bill 1292 "An Act to provide that any energy savings realized by constituent institutions of the University of North Carolina shall remain available to the institution and a portion of those energy savings shall be used for other energy conservation measures…" NC General Assembly, Session 2009

While saving energy and money is important, meeting state and university energy-related policies is a statutory requirement.

Per the Climate Commitment signed by Chancellor Everts,[6] "We believe carbon neutrality and resilience are extremely high priority areas of action for all institutions and we aim to lead the nation in these efforts."

"Toward Climate Neutrality"[7] signed by former Chancellor Peacock states "Appalachian State University leads in creating a world where environmental, societal, and economic qualities exist in balance to meet the needs of today and of future generations. Our community of students, faculty and staff continually advance our understanding, capabilities and practices in this vital journey. As an institution of higher learning, we lead by example, inspiring new generations prepared to share this knowledge, ingenuity and passion." Our Sustainability Vision includes implementing and continuously "improving efficiency and renewable strategies, demonstrating the University's commitment to climate change mitigation."

The University of North Carolina Sustainability Policy[8] states "The University shall develop a plan to become carbon neutral as soon as practicable and by 2050 at the latest, with an ultimate goal of climate neutrality."

Although Executive Order 80[9] does not specifically apply to the UNC system, it states that

> *"North Carolina will strive to meet the following by 2025:*
> *a. Reduce statewide greenhouse gas emissions to 40% below 2005 levels,*
> *b. Increase... ZEVs…*
> *c. Reduce energy consumption per square foot in state-owned buildings by at least 40% from FY 2002-2003 levels."*

These targets will not achieve the carbon neutrality goals outlined in "Toward Climate Neutrality" and "The University of North Carolina Sustainability Policy."

Energy and Water Goals

Energy and Water Goals Discussion

As mentioned earlier, Chancellor Everts states "We believe carbon neutrality and resilience are extremely high priority areas of action for all institutions and we aim to lead the nation in these efforts."[10] During its time as a UNC energy leader, Appalachian had exceeded the guidelines in the SB668 ratified in 2007; by 2016-17 Appalachian was the UNC system's leader in energy reduction and third in water

[6] From the "Second Nature Climate Leadership Statement," signed by Chancellor Sheri Everts on January 4, 2016
[7] From "Towards Climate Neutrality," developed by the University Sustainability Council and approved by Chancellor Kenneth Peacock dated September 16, 2010
[8] From "The UNC Policy Manual," 600.6.1, Adopted 10/09/09, Amended 06/14/13
[9] Executive Order No. 80 "North Carolina's Commitment to Address Climate Change and Transition to a Clean Energy Economy" Governor Roy Cooper, October 29, 2018
[10] From the "Second Nature Climate Leadership Statement," signed by Chancellor Sheri Everts on January 4, 2016

reduction. Last year we were 4th in energy reduction and tied for 6th in overall EUI within the UNC system.

To be in tune with our overall goals, we must refer to our commitments outlined in "The UNC Policy Manual," the "Second Nature Climate Leadership Statement," and "Towards Climate Neutrality." We should also consider the goals in EO80.[11] Three of these four documents require climate neutrality by 2050.

SIMAP™ [12] is the tool the University uses to tracks our GHG emissions; this SEP outlines the strategy and tactics that will be used to achieve these goals. *This SEP will cohesively link EUI and GHG emissions so accurate goals can be made.*

Appalachian has also made a commitment to "implement rigorous campus-wide water conservation practices."[13]

KPI 1: GHG (Green House Gas Emissions)

GHG Emissions Discussion

GHG emission reductions must be reduced to 0 tons eCO_2 (equivalent CO2) by 2050. Because GHG is dependent on the fuel sources used to power the university, not just the energy used, it needs to be tracked as a separate target from EUI. GHG emissions for the Strategic Energy Plan only include the emissions that come from purchased electricity and fuels burned in University facilities and vehicles. Other GHG emissions related to the university fall under the auspices of the Office of Sustainability.

GHG is dependent on the fuel sources used to power the university, not just the amount of energy used. Since it is not normalized to the campus's size, it is a good indicator of the overall energy used by the university and how the energy is produced. As such, it is a more reasonable reflection of our actual GHG load than EUI.

The different standards make selecting our target values a conundrum. If we select the "Towards Climate Neutrality" baseline and targets, we would have to reduce GHG emissions by 25.2% in 2019-2020. The EO80 approach is the most modern; while it has some issues, it is the best choice for now.

With the EO80 targets we need to drop our GHG 11.5% this year. We use a best fit 2nd order curve to ensure our EO80 objective lines up with the stipulated goals. Reductions will be larger and more difficult as we get closer to the 2050 target date. The formula used for the predictions are shown in Stationary Facility GHG and University Vehicles Target Emissions Goal Calculations on page 22.

Stationary Facility GHG Target Emissions and Existing Conditions

While our stationary facility emissions[14] were showing a downward trend, we are not on track to meet the target of zero emissions by 2050 (reference Figure 1 on page 7). We need to reduce our GHG

[11] Executive Order No. 80 "North Carolina's Commitment to Address Climate Change and Transition to a Clean Energy Economy" Governor Roy Cooper, October 29, 2018

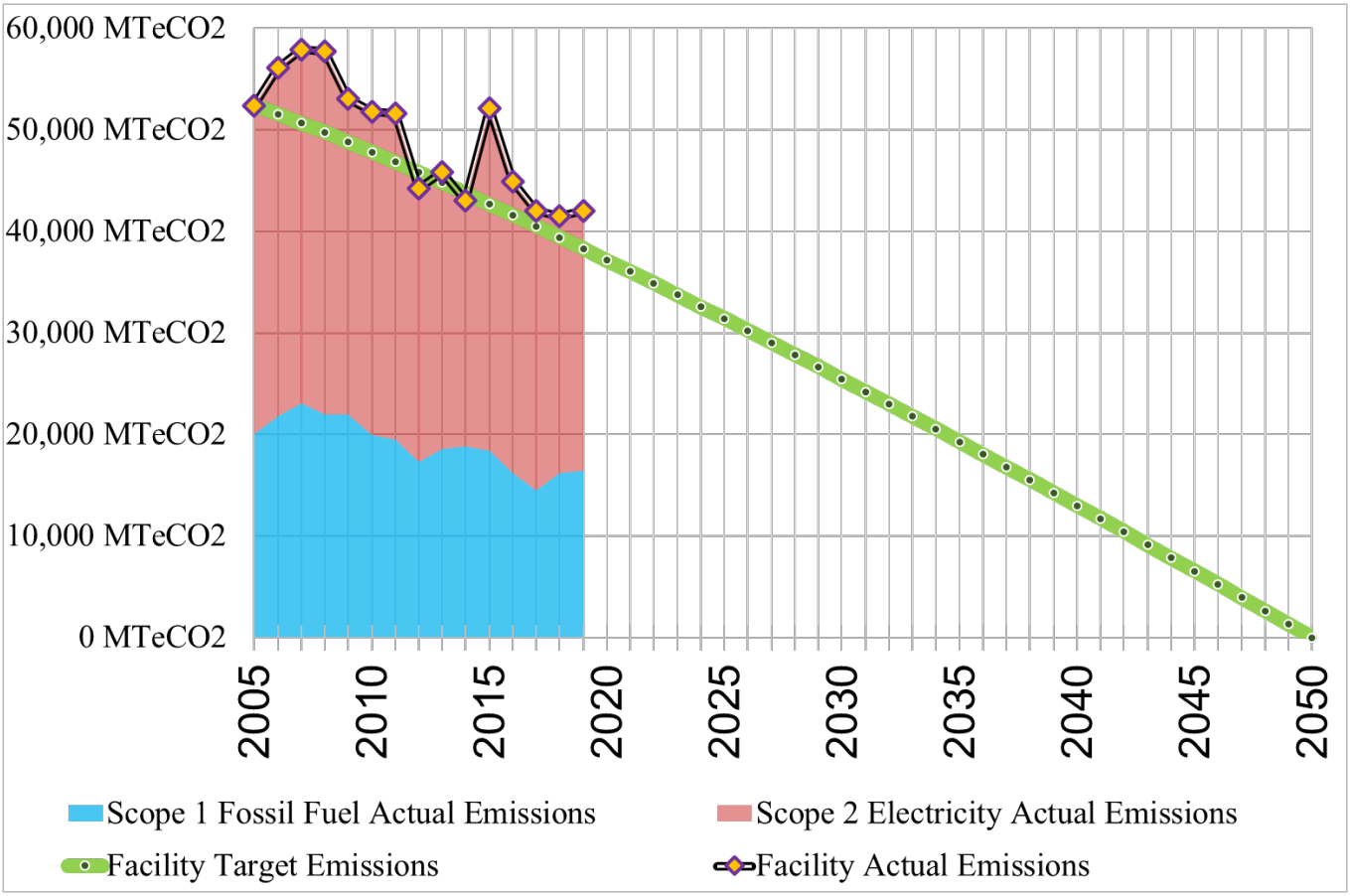
[12] SIMAP™ is the "Sustainability Indicator Management and Analysis Platform" developed by the University of New Hampshire and used by Appalachian

[13] "Appalachian State University Master Plan 2025 2016-2017," Design Guidelines & Standards, page 108: Sustainability & Environmental Stewardship Standards

[14] "Stationary Combustion" under Scope 1 and all Scope 2 include all the emissions from the campus stationary facilities

emissions by 4,851 MTeCO2 in 2019-20 to get back on track to a reasonable 3.4% average reduction per year from 2020 to 2025.

Figure 1. Actual and Target Stationary Facility GHG Emissions for 2050 Net-Zero using Governor's EO80 Baseline



Since our electricity emissions are three times higher than our fossil fuel emissions, electricity should be a prime target.

If equally distributed, this corresponds to a reduction this year of:

- 2,265 $MTeCO_2$ reduction in Steam Plant fossil fuel emissions
- 2,586 $MTeCO_2$ reduction in Electricity emissions
- No $MTeCO_2$ reduction in University vehicle and fleet emissions required this year

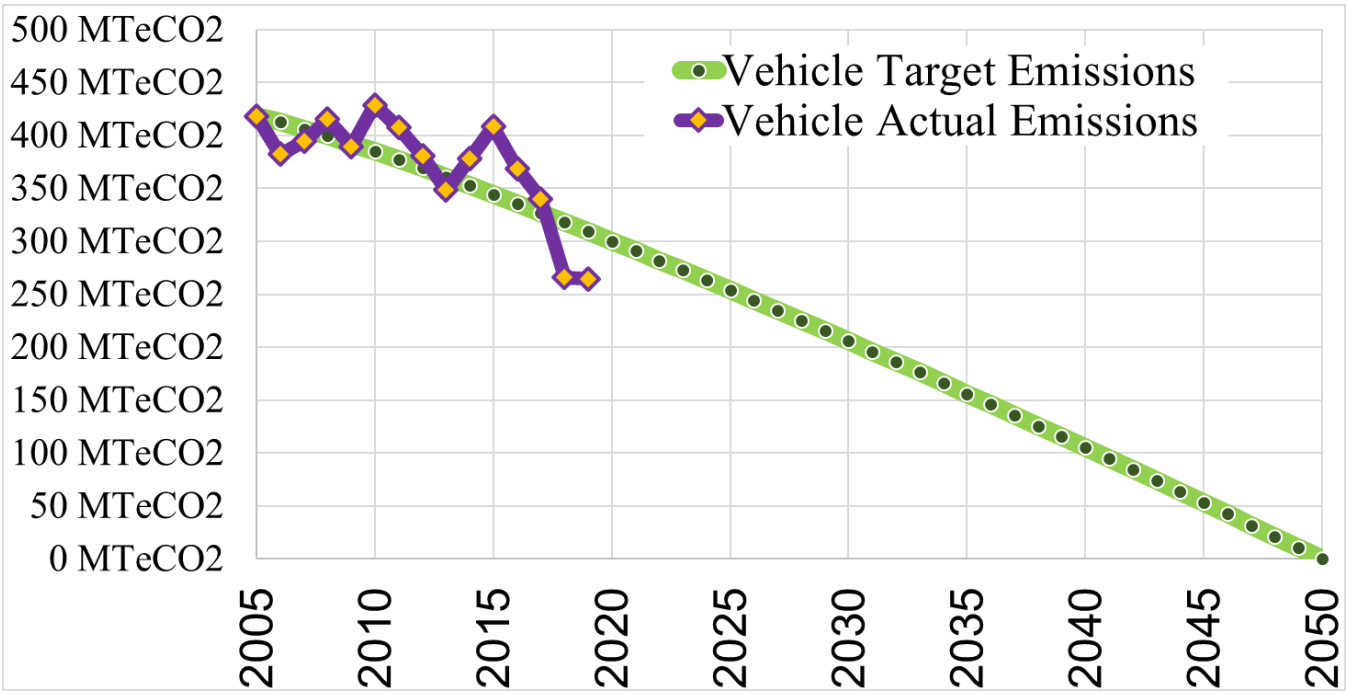
University Vehicles and Fleet Emissions and Existing Conditions

The University's Vehicles and Fleet[15] emissions are showing a significant downward trend, but are not on track to meet the target of zero emissions by 2050 (reference Figure 2 on page 8). The

[15] Includes all work trucks and fleet rentals controlled by Appalachian State University. Does not include AppalCART, commuting, etc.

University should continue the present trend towards more fuel efficient and EV-based transportation. The formula used for the predictions are shown in Stationary Facility GHG and University Vehicles Target Emissions Goal Calculations on page 22.

Figure 2. Actual and Target University Vehicle and Fleet GHG Emissions for 2050 Net Zero using Governor's EO80 Baseline



KPI 2: EUI and WUI (Energy Usage Intensity and Water Usage Intensity)

Usage intensities measure the efficiency of our campus. As such, we can determine how we are doing independent of the size of the campus. Anything that uses energy (lighting, heating, etc.) is counted as part of the square footage of the campus, including dormitories, athletic facilities, student services, parking decks, leased facilities, chiller plants, etc.

The target usage intensities are dependent on three major factors:

1. *Total energy or water used in the FY*
2. *Total square feet of all facilities using power*
3. *GHG energy mix*[16]

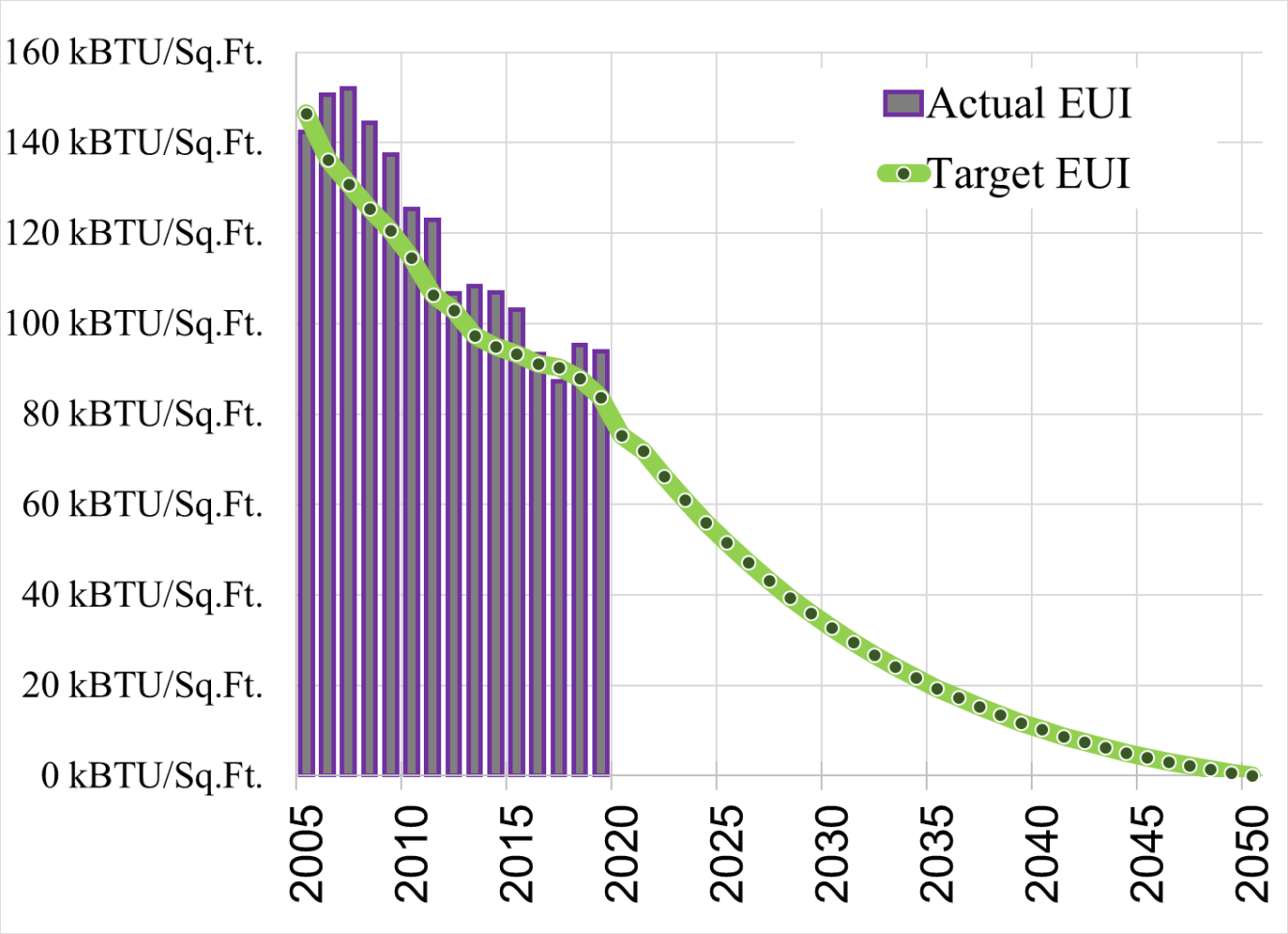
The formula used for the predictions are shown in EUI Goal Calculation on page 23 and in WUI Goal Calculation on page 23.

Figure 3 on page 9 shows the actual and predicted EUI's. We need a 19.9% or a 18,678 BTU/ sq.ft. overall reduction for 2019-2020. We will achieve 23% of that target (4,030 BTU/sq.ft.) if the stadium

[16] The square footage predicted target is the planned construction if it is known and, if not, 1.5% per year (the 15-year average was 2.6% per year)

parking deck and the two new P3 buildings (Buildings 100 and 200) are net-zero. If Leon Levine Hall and Sanford Hall were net-zero in addition to the above, we would achieve 63% of that target (11,800 BTU/sq.ft.).

Figure 3. Actual and Target Energy Usage Intensity



Appalachian plans to "implement rigorous campus-wide water conservation practices."[17] Figure 4 on page 10 and Figure 5 on page 10 show that Appalachian has achieved an amazing 52% WUI reduction, but little has changed since 2012. In order to meet this goal, we need to keep reducing our WUI. Our overall water use is the same as it was in 2010. To make a 2.5% WUI reduction, Appalachian needs to target 16.7 gallons per square foot, requiring a reduction of 4.6 million gallons.

[17] "Appalachian State University Master Plan 2025 2016-2017," Design Guidelines & Standards, page 108: Sustainability & Environmental Stewardship Standards

Figure 4. Water Usage Intensity History

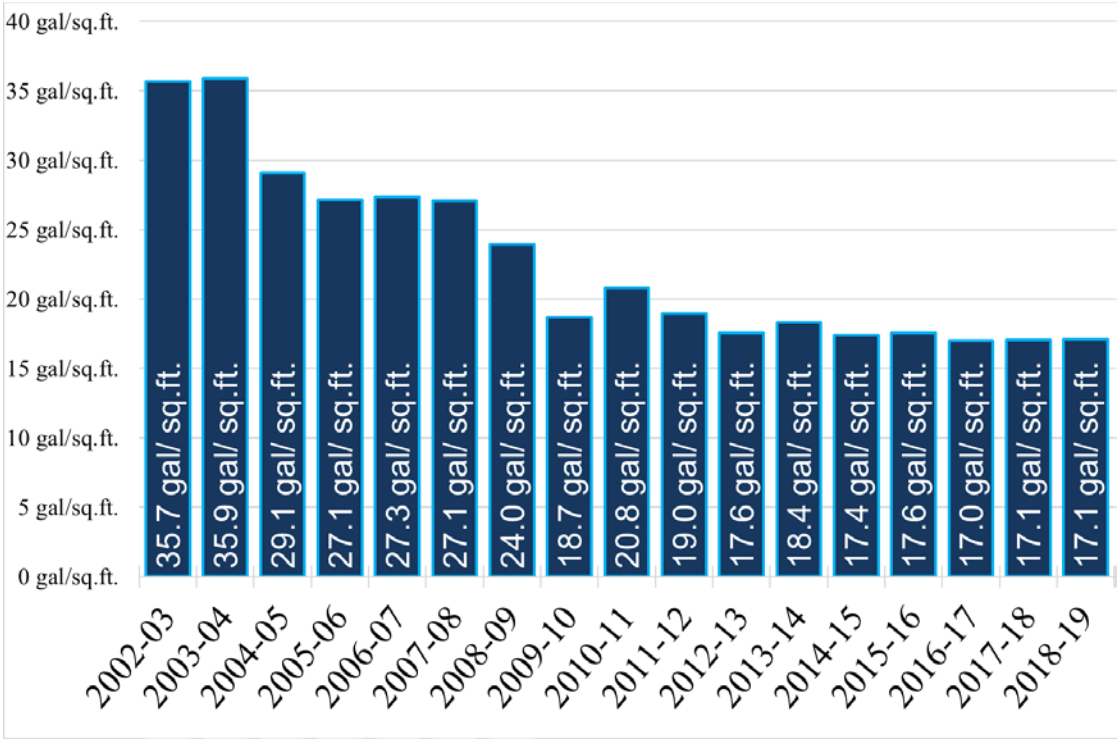
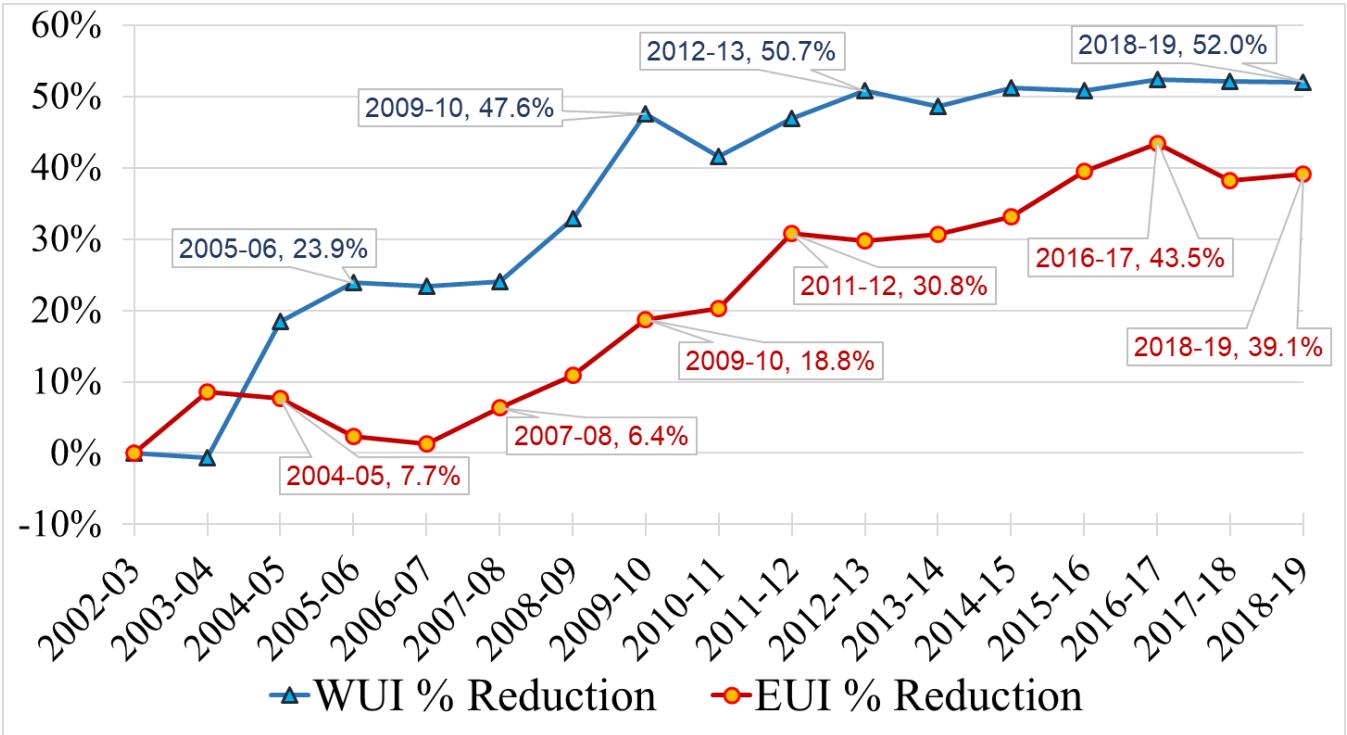


Figure 5. Water and Energy Usage Intensity Reductions Based off 2002-2003



KPI 3: Energy and Water Expense

The above steps will reduce energy expense by 2.5% per year, including expected energy cost increases at this time. With a 5% WUI reduction per year, water and sewer expense may not have a 5% reduction if the rates do not stabilize.

The following section details the energy and water expenditures. Figure 6 on page 11 shows what the University pays for raw fuels and burdened electricity. Steam is produced from some of the fossil fuels with distribution, R&R (repair and renovation), fuel, and operational costs rolled in. Figure 7 on page 12 shows the amounts charged by the University. Figure 8 on page 12 shows the cost of water and sewer for each fiscal year. Water and sewer numbers for 2007 through 2010 are unreliable, so they have been left off the chart.

Figure 6. University Energy Expense (Electricity and Raw Fossil Fuels)

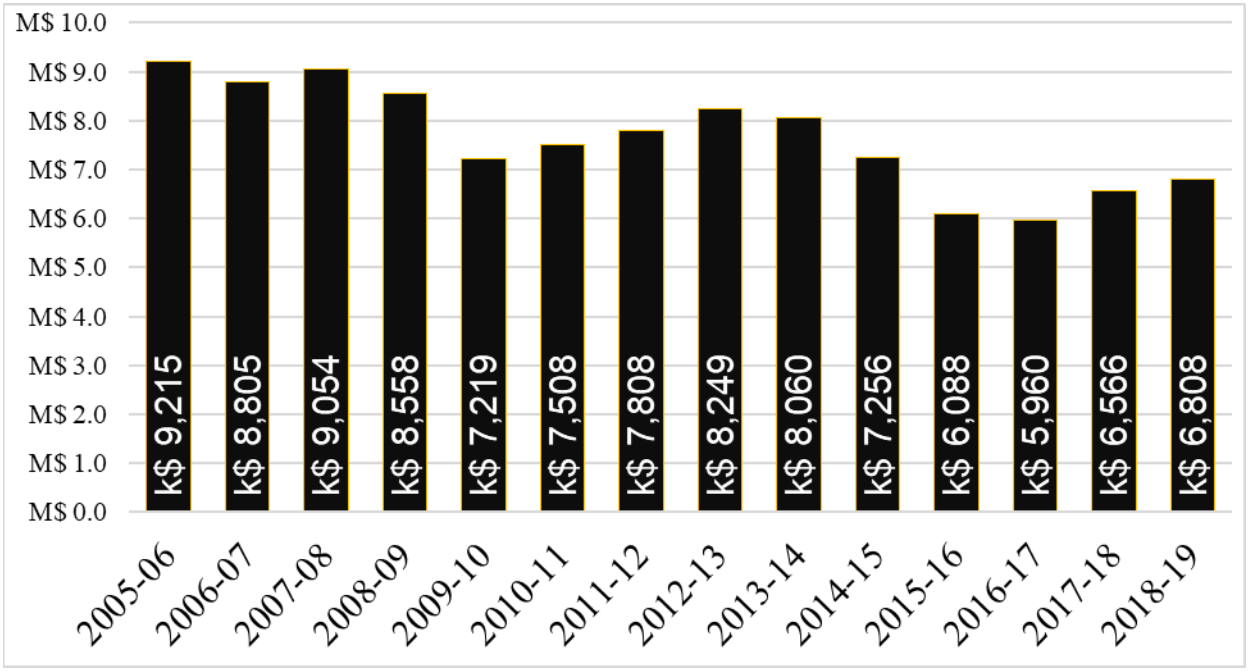


Figure 7. University Energy Expense (Steam and Electricity)

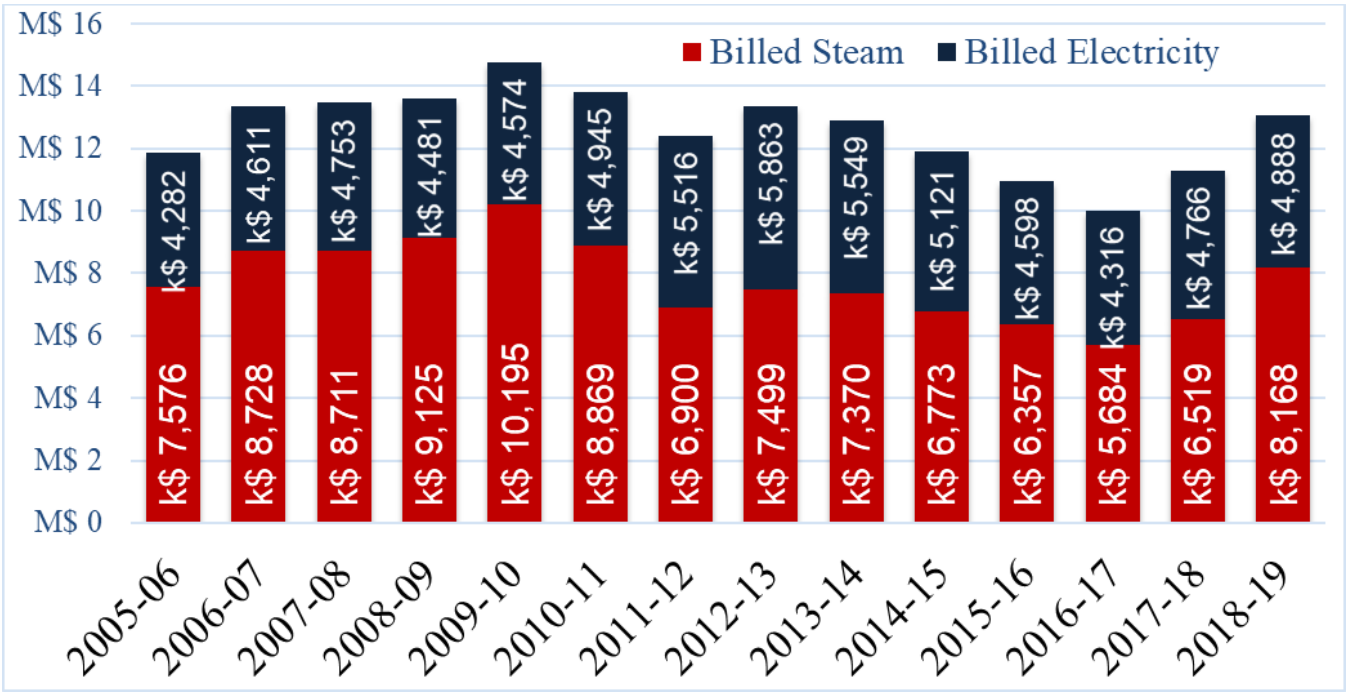
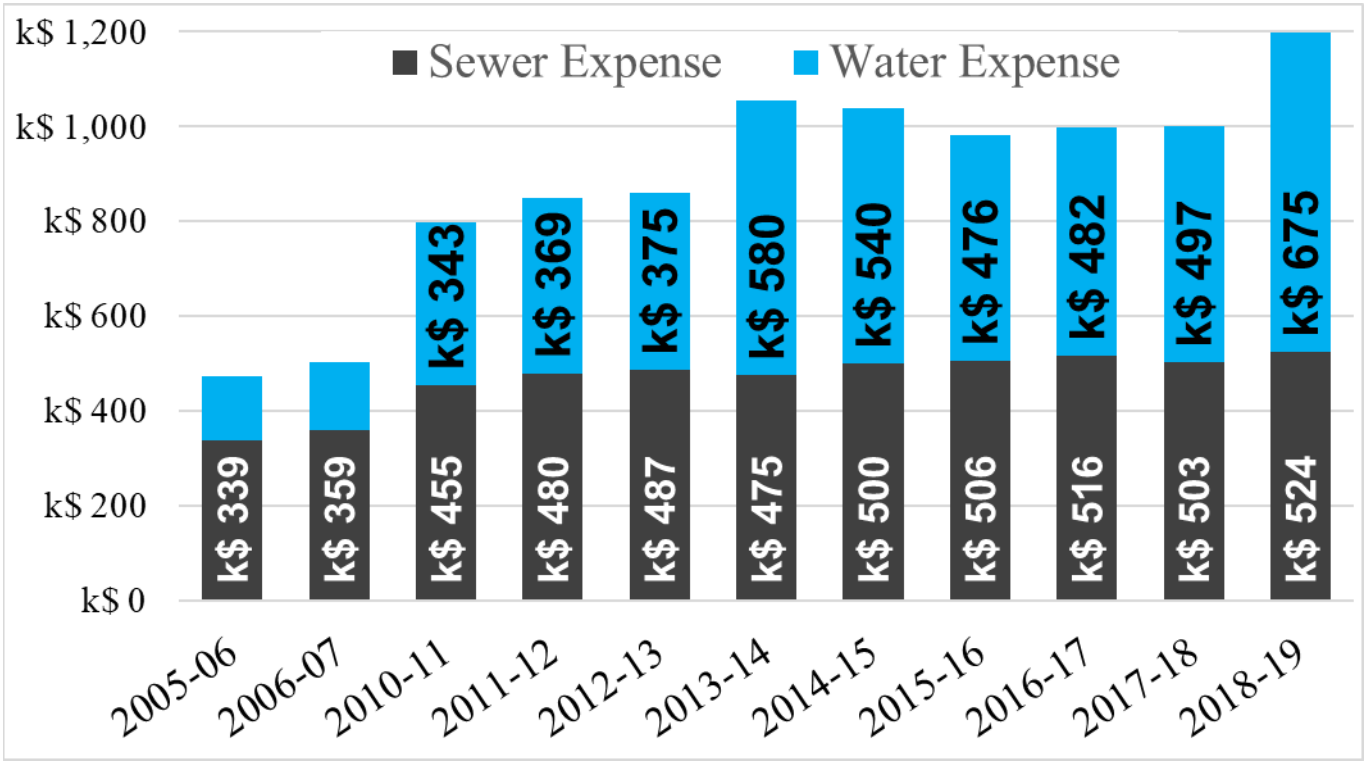
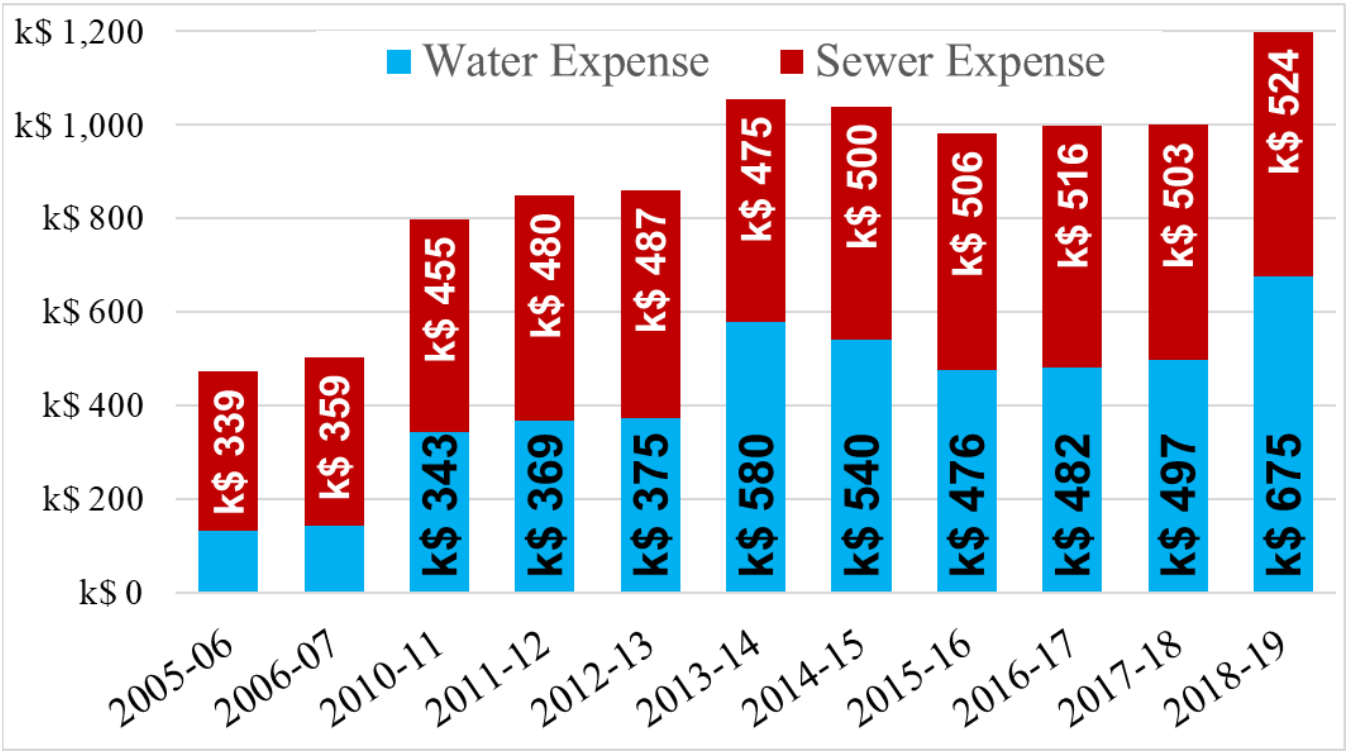


Figure 8. University Water and Sewer Expense (2007-2010 Unavailable)

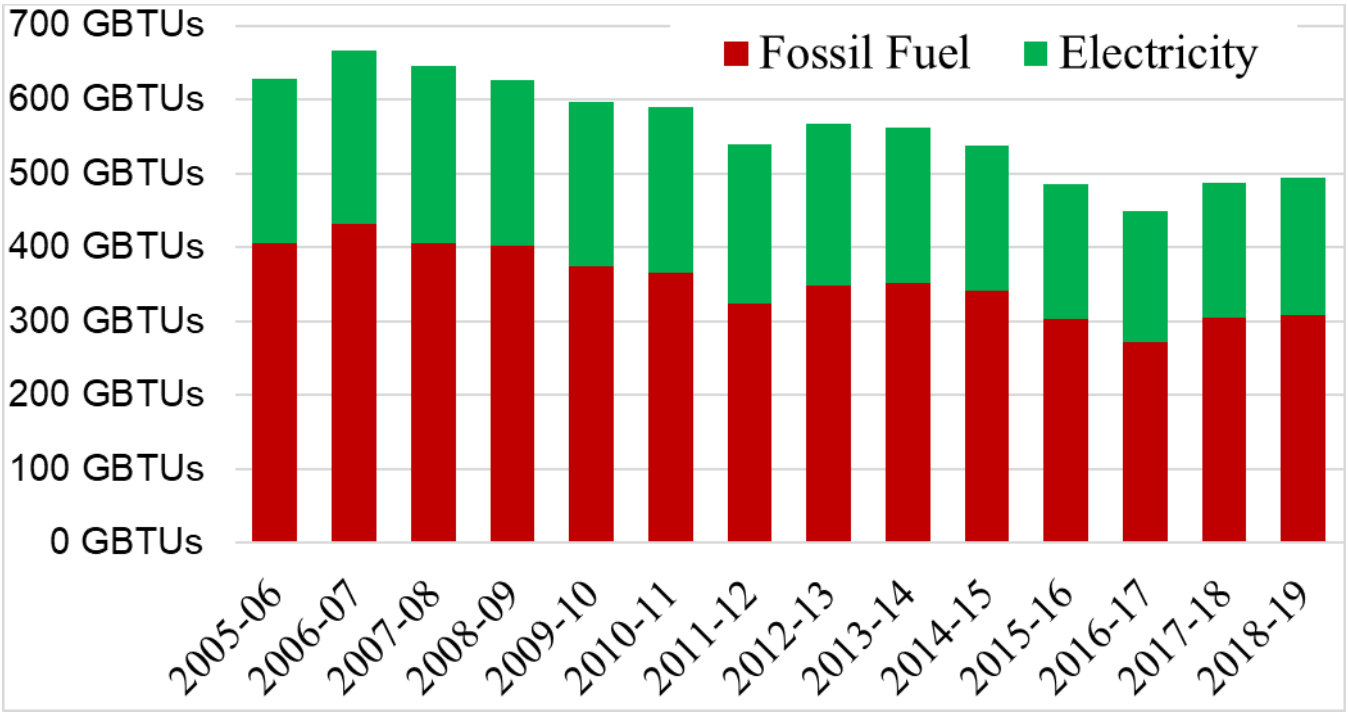




Energy Sources

Steam and electricity are the two primary types of energy used at Appalachian to operate our facilities. The University's state-of-the-art steam facility burns fossil fuels -- either natural gas or fuel oil. Electricity is purchased from Blue Ridge Electric Membership Corporation (who procures their electricity from Duke Energy Corporation). A small amount of energy is provided by on-campus solar and wind resources. Figure 9 on page 14 shows the amount of energy Appalachian uses each fiscal year by energy type.

Figure 9. Appalachian On-Campus Non-Transportation Energy Types



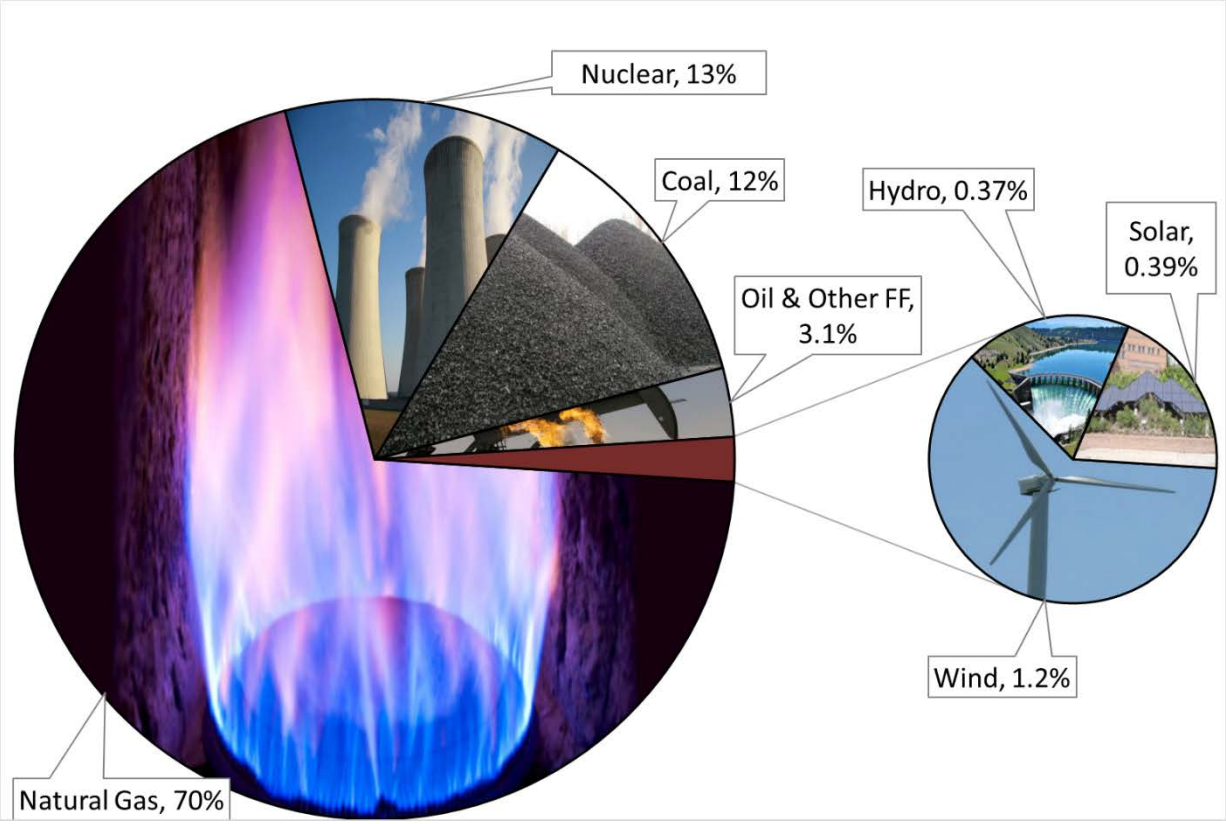
Combining our on-campus energy sources with the fuel distribution provided by Duke Energy Corporation's annual reports, Appalachian received its total energy (both electricity and steam) from the following fuels in 2018-2019:

- 86% Fossil Fuel (70% natural Gas, 12% Coal, 3% fuel oil, and traces of propane, kerosene, etc.)
- 13% Nuclear
- 1.2% Wind
- 0.39% Solar
- 0.37% Hydroelectric

Figure 10 on page 15 shows a detailed breakdown of all of Appalachian's energy sources, including those from our electricity provider.

Our present electricity is, on-average, three times more carbon intensive than energy produced by our steam plant. Thus, the majority of our GHG reductions will come from the electricity sector. As our purchased electricity is generated by lower carbon sources, our GHG reductions will migrate to the fossil fuel sector.

Figure 10. Appalachian State University Non-Transportation Energy Sources



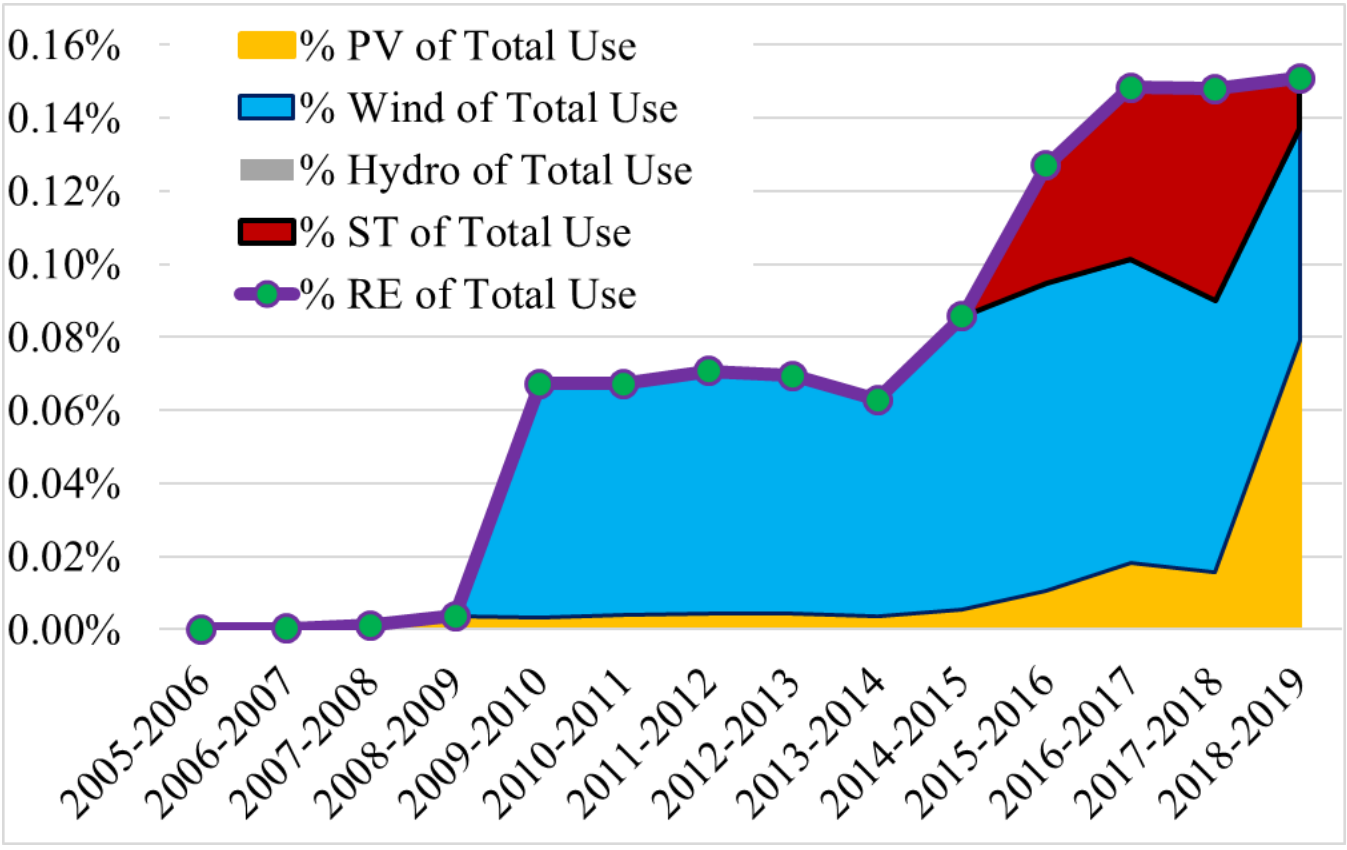
On-Campus Renewable Energy Sources

A detailed list of campus renewable sources is made available by the Office of Sustainability. Appalachian has embraced photovoltaic (PV) generation as the optimal choice for our area. Wind and Solar Thermal either require high maintenance or do not perform well on campus. In 2018-2019 on-campus renewable energy provided 0.151% of Appalachian's energy, as shown in Figure 11 on page 16. The 2015-2019 Strategic Plan[18] had required that 0.5% of Appalachian's total consumed energy came from university owned renewable energy systems by 2018-2019.

The ASUREI has funded 100% of renewable energy projects on campus since 2012. Since 2007, the ASUREI has installed 104 kW of PV on campus. Other departments have helped the ASUREI install another 6 kW of PV. They teamed up with New River Light & Power to install a 100kW wind turbine in 2009. Unfortunately, only 9% of our 653 kBTUh solar thermal capacity on campus was operating in 2018-2019. These systems were installed by Housing, the Physical Plant, and the ASUREI. Housing's 592 kBTUh capacity was not operational in 2018-2019. High maintenance is one reason we are moving away from solar thermal.

[18] "The Appalachian Experience: Envisioning a Just and Sustainable Future, The Strategic Plan of Appalachian State University, July 2014 through June 2019," Section 6, page 12, "Metrics"

Figure 11. On-Campus Renewable Energy Percentage of Total Appalachian Energy Use by Type



Energy Conservation Measures

Funding Energy Conservation Measures

ECM funding is difficult on a limited budget. Appalachian has historically used ESPC's to fund energy improvements, but the actual savings can be much less than those in the contract. Since the ESPC is not responsible for future maintenance, reliability and occupant comfort have been a problem. In contrast, Appalachian's self-performed ECM's have reduced energy by 24% with less overhead than an ESPC and high occupant satisfaction and system reliability.

Other UNC Universities use HB1292[19] to take ECM savings and roll it forward to generate additional savings. For example, Western Carolina University used their first 1292 carry forward of $12k in 2012-

[19] Per HOUSE BILL 1292 Article 1 of Chapter 116 of the General Statutes is amended as follows:
§ 116-30.3B. Energy conservation savings.
(a) In addition to the funds carried forward under G.S. 116-30.3, the General Fund current operations appropriations credit balance remaining at the end of each fiscal year for utilities of a constituent institution that is energy savings realized from implementing an energy conservation measure shall be carried forward by the institution to the next fiscal year. Sixty percent (60%) of the energy savings realized shall be utilized for energy conservation measures by that institution. The use

2013 to grow it to $103k in 2017-2018 by reinvesting the funds. North Carolina State University has been receiving over $1M per year in 1292 funds each year until FY 2018-2019 when Duke Energy Corporation had a large rate increase.

Appalachian has $328,620.35 in HB1292 funds to invest in 2019-2020. Following HB1292's guidelines, $192,172 "*shall* be utilized for energy conservation measures[20]." The remainder can be used by the institution and "shall be limited to onetime capital and operating expenditures that will not impose additional financial obligations on the State" which can include additional ECMs.

Detailed ECM's are identified in In the EPL (Energy Project List), also known as the IPL (Integrated Priority List).

Recommendations for 1292 Funds in 2019: High Return on Investment (ROI) Projects

The energy sector would consider the projects in this section "low hanging fruit."

Belk Library and Information Commons

HVAC: $40k

- Update air handling unit (AHU) and variable air volume (VAV) programming as defined in the EPL
- Implement Events2HVAC

Water: $10k

- Install low flow fixtures in the Atrium bathrooms
- Test and repair any worn valve kits on all remaining fixtures.

Bookstore Chiller Plant: TBD <$100k

No firm quote has been performed. All hardware is already in the system but has not been used. Some variable frequency drives (VFD's) for variable condenser water and a basin heater are expected. An additional Metasys controller with sequence of operations and testing will be required; most of the expense will be in programming.

- Implement operation using existing Plate and Frame Chiller
- Develop chilled water reset

of funds under this section shall be limited to onetime capital and operating expenditures that will not impose additional financial obligations on the State. The Director of the Budget, under the authority set forth in G.S. 143C-6-2, shall establish the General Fund current operations credit balance remaining in each budget code of each institution.

(b) The Director of the Budget shall not decrease the recommended continuation budget requirements for utilities for constituent institutions by the amount of energy savings realized from implementing energy conservation measures, including savings achieved through a guaranteed energy savings contract.

[20] House Bill 1292 "An Act to provide that any energy savings realized by constituent institutions of the University of North Carolina shall remain available to the institution and a portion of those energy savings shall be used for other energy conservation measures…" NC General Assembly, Session 2009

College of Education: TBD <$20k

- Add one network automation engine (NAE) and six CO_2 sensors and associated sequence programming

Garwood Hall: TBD <$15k

- Implement an operable scheduling system
- Update VAV sequences to support temporary occupancy

Holmes Convocation Center: TBD <$75k

Lighting

- Install networked Arena occupancy sensors to control HVAC (standby) and the new instant-on Arena LED Court and Shutter lights. The new lighting system has an occupancy input for lighting control along with dry contact outputs compatible with our JCI controls.

HVAC

- Utilize networked occupancy sensors in Arena to control HVAC system
- Improve sequences

Anne Belk: TBD <$15k

- Implement improved hot water reset for pneumatically-controlled spaces.

Emergency and Stair Lighting (any remaining funds, $60-120 per fixture)

Emergency and stairway lights are on 24 hours a day, 365 days a year. Most of our emergency lighting is still fluorescent and should be converted to LED. Retrofitting anything large than a 2x4 T-8 fixture with an equivalent LED costs around $60 per fixture, including labor. The first tier ROI is under 5 years.

2019-2020 Plans

Steam

In 2019-20 we need to make the total steam system operate 12% more efficiently.

We have a 25% conversion loss between the fossil fuel energy used and the steam leaving the plant. We then lose 32% of the water (steam) leaving the Steam Plant as compared to the amount recovered (condensate).

- Install an economizer on Boiler #4; as we continue to reduce steam load, this smaller boiler is more heavily used. All of the three remaining boilers have an economizer.
- Test 100% of all steam traps utilizing the latest trap testing technology and repair non-optimal traps.
- Test 100% of all heat exchangers utilizing the latest testing technology and repair any with issues.
- Scan all high, medium, and low pressure steam valves and lines ultrasonically for leaks. Repair when practical.

HVAC

- Create a team and begin re-commissioning, repairing equipment and updating building sequences to the latest specifications as buildings are evaluated.
- Develop new sequences of operation based off the latest standards and research performed in our learning labs.
- Implement a temperature and occupation policy at the Chancellor level.
- Institute a plan to convert all non-DDC (direct digital control) buildings with a lifetime longer than eight years to DDC.

Electricity

- Convert the remaining 1,000 exterior HID lights to LEDs. A detailed list is being compiled.
- Continue LEDCart program, an education and outreach run by the New River Light & Power, the Office of Sustainability, and the Physical Plant that is administered by students.
- Develop a plan for 100% conversion of all interior lights to LED for buildings with a 10-year or longer lifetime

Construction

All new construction and significant remodels must be net-zero. If Leon Levine Hall, Sanford Hall, P3 Building 100, and P3 Building 200 had been net-zero buildings instead of reducing all buildings' EUI by 17.5%, we would only have to reduce the older buildings by less than 10%.

Other

- Bring a full-time Energy Manager to Appalachian State University.
- Begin plans for a 3-person energy strike team to identify and implement energy and comfort improvements.

Long-Term Goals

These are some high ROI goals that should be started in the 2020-2021 fiscal year (FY).

Steam

- Implement a 100% testing and repair of steam trap, valve, and heat exchanger test policy by FY 2020-2021.
- Support and fund steam plant team recommendations to increase efficiency.
- Develop a staged plan by 2022 to either eliminate fossil fuel use in the Steam Plant or determine an alternative heating method by 2045.

Electricity

- Migrate to a total renewable microgrid with large scale renewables and battery storage.
- Implement Chiller Loops between buildings whenever we perform grounds construction. Chillers are high-energy users that operate best at high loads. Often, one chiller can supply multiple buildings much of the time.
- Use existing plate and frame equipped chillers.
- Include air quality as a factor in all energy improvements.
- Optimization for energy and comfort at the zone level: sequence, unoccupied setpoints, ZN-T

(zone temperature) maintainability, and occupied recovery time.
- CO_2 control: optimize balance and appropriate interaction between room level and AHU level.
- Evaluate and implement CHW and Condenser water resets.
- Eliminate the use of Pneumatics (Actuators and controls) in *all* new and retrofit HVAC systems.

Combined Steam and Electricity

- Bring sequences up to date (ASHRAE RP-1455 or newer) and renew experimentation and development.
- Improve HHW resets based off zone demand (like the DAT reset). Presently we use reset based off OAT, which can waste energy. With an OAT reset, we must design for possible worst case (windy, cold. etc.) which can waste energy if the building has a sufficient internal load or cause cold conditions if there is a light internal load or significant building envelope problems.
- Turn off DHW and HHW pumps when not required (unoccupied and/or no call for heat)

Water Conservation Measures

Past Progress

Appalachian has a stellar history of water conservation, dropping our water use intensity by 51% between our 2002-2003 baseline and 2013. Since 2013, we have only reduced an additional 1.3% compared to the baseline.

2019-2020 Goals

- Update urinals and toilets to low-flow fixtures on the first floor of Belk Library and Information Commons.
- Develop a test, tune, and repair procedure for insuring toilets, urinals, and faucets are in good order and operating at peak efficiency. This process must be performed once a year in each building on a rotating basis. We should begin the process at Belk Library and Information Commons and continue from there.
- Plan replacement of all fixtures with ultra-low flow units for all buildings with a lifetime >= 10 years.
- All new and remodeled buildings will use the highest efficiency fixtures. Waterless urinals will be used in all new construction.

Long-Term Goals

- Begin replacement of existing fixtures for completion by 2025
- All new and remodeled buildings will use the highest efficiency fixtures. Waterless urinals will be used in all new construction.
- Develop plan for gray water use wherever possible in all new construction and existing high water use buildings.

GHG Reduction Measures

New and Remodeled Buildings

Past Progress

Appalachian does not have a policy on energy efficiency of new buildings. Over the last few years, new or significantly remodeled buildings have EUIs that varied between 32 kBTU/sq.ft. to 133kBTU/sq.ft. None are net-zero despite lifetimes lasting well beyond 2050.

2019-2020 Goals

Write an enforceable policy requiring all buildings built, remodeled, or leased by the University be net-zero or net-positive buildings.

Long-Term Goals

Implement the previously mentioned policy requiring all buildings built, remodeled, or leased by the University be net-zero or net-positive buildings.

Renewable Energy

Past Progress

Renewable energy (RE) is not prevalent across Appalachian's campus. Most operational installations were funded by the students.

2019-2020 Goals

- Actively support all ASUREI student-funded roof-top and/or ground mount PV or wind installations.
- Support ASUREI's plans to install an 80-100 kW net-metered array behind the Data Center located at the University's State Farm Road property.
- Develop an Appalachian State University policy to require University-funded renewables be implemented in all new projects.
- Develop an actionable plan towards a fossil fuel free campus heat system.
- Plan a 175 kW to 400* kW array on Plemmons Student Union when it is re-roofed in the near future. A 175 kW array will occasionally make Plemmons' electricity load net-zero and generate enough energy to offset 16% of Plemmons' total electricity use. A 400 kW array will make Plemmons' electricity net-positive 20% of the time and supply 37% of the facility's electrical energy. The ASUREI is interested in helping to fund this project.

Long Term Goals

- Install PV on Plemmons' roof as described above.
- Develop Appalachian State University funded RE projects.
- Install PV on all suitable rooftops, parking lot canopies, or other high ROI locations.
- Consider P3's or donations to fund more RE. Name and label projects after donors.
- Strive towards sourcing our electricity from renewable sources. Historically Appalachian's New River Light & Power (NRL&P) has not been able have any input on their energy sources. In 2022, NRL&P will be starting a 30-year agreement with NTE, enabling more choices about

* Corrected 4000 kW to 400 kW. Approved via email 9/17/19 patrick richardson

their energy sources.
- Implement a fossil fuel free campus heat system.

University Transportation: Electric and Hybrid Vehicles

Past Progress

The past years have seen progress in Appalachian's vehicle mix. The vehicles at the end of 2018-2019 included:

- One Chevrolet Volt hybrid this year (2.5% of the Motor Pool fleet)[21]
- Three EV's with built-in solar charging (the Chancellor's 6 seat GEM and two Office of Sustainability GEMs).
- Two EV's grid-powered (IT's GEM and NRLP's Nissan Leaf)

2019-2020 Goals

- Aggressively pursue identifying suitable ZEV or low emission replacements for the 300+ vehicles in the University maintenance and operations fleet.
- Increase the number of electric vehicle charging stations on campus by 25% each year.[22]
- Ensure all new and replaced golf-cart style vehicles used by Academics, IT, and Athletics are ZEV.

Long-Term Goals

- Completely eliminate the use of fossil fuel-based vehicles by 2050.
- Increase the number of electric charging stations on campus by 25% each year.[23] Identify a method to fund these facilities, which may include
  - Charging for the use of electricity
  - Charging a demand fee during high use periods
  - Receiving a discount for providing energy to the campus during peak demands.

Appendix

Formulas

Stationary Facility GHG and University Vehicles Target Emissions Goal Calculations

The formula uses a best fit second order quadratic equation where the baseline year target

$$m_{GHG} = \frac{BaselineYearActualEmissions}{((BaselineYear - YearMin)^{GHGExp} - (TargetYear - YearMin)^{GHGExp})}$$

[21] Per Bob Smith, Motor Pool Director
[22] Based off Legends Charging Station utilization each fiscal year from 2015-2019. In 2015-16, the system produced 87% more energy than was used charging ZEVs; however, in 2018-19 it was only able to produce 65% of the energy used. EV's are now heavily utilizing the facility.
[23] Based off Legends Charging Station utilization each fiscal year from 2015-2019. Usage has increased by an average of 26% per year.

$$b_{GHG} = BaselineYearActualEmissions - m_{GHG} * ((BaselineYear - YearMin)^{GHGExp}$$

$$GHG_{target}\ as\ f(year) = m_{GHG} * (PresentYear - YearMin)^{GHGExp} + b_{GHG}$$

Where:

- GHG_{target} (in $MTeCO_2$) is the GHG goal for the year of interest
- m_{GHG} (in $MTeCO_2$ per year) is the change in the GHG emissions per year including the *GHGExp*
- b_{GHG} (in $MTeCO_2$) is the Target GHG when at *BaselineYear - YearMin*
- *BaselineYearActualEmission*s (in $MTeCO_2$) is the GHG emissions at the baseline
- *BaselineYear* (in years) is the year to start the calculation.
- *YearMin* ((in years) is a number less than or equal to the *BaselineYear* for convenience in calculations
- *GHGExp* (dimensionless)is used to change the shape of the line to match any specific target values such as the EO80 goal.

EUI Goal Calculation

$$EUI_{target} as\ f(year) = \frac{GHG_{target}}{PredictedSqFt * ExpectedConvRatio}$$

Where:

- EUI_{target} (in BTU per square foot per year) is the EUI goal for the year of interest
- GHG_{target} (in $MTeCO_2$) is the emissions target for the year of interest (see Stationary Facility GHG and University Vehicles Target Emissions Goal Calculations on page 22)
- PredictedSqFt (in square feet) is the University's predicted square footage for all spaces that use power. If the planned construction is not known, the prediction uses 1.5% per year (the 15-year average was 2.6% per year)
- ExpectedConvRatio (in $MTeCO_2$/MMBTU) is the average conversion rate of energy to GHG emissions for the previous recorded years

WUI Goal Calculation

$$WUI_{Target}\ as\ f(year) = PrevWUI * (1 - TargReductionRate)$$

Where:

- WUI_{target} (in gallons per square foot per year) is the WUI goal for the year of interest
- PrevWUI ((in gallons per square foot per year) is the WUI from the previous year
- TargReductionRate (dimensionless in percent) is how much we want to reduce the WUI by each year.

Revision History:

- 9/17/2019: PV typo (4000kW to 400kW) corrected on page 21. Approved by Nick Katers.
- 1/28/2020: Reflect improved targets based off corrections to the scope 2 GHG profile in late 2019. Correct graphs impacted by these changes. Approved by Nick Katers for release without new signatures on 1/27/20.

Definitions

Term	Definition	Description
ASUREI	Appalachian State University Renewable Energy Initiative	A group funded and operated by students to reduce the environmental impact of Appalachian State University by implementing renewable energy technologies, investing in energy efficiency projects, and promoting campus engagement. (source: ASUREI mission statement)
BTU	British Thermal Unit	A BTU is the amount of energy it takes to heat one pound of water 1° Fahrenheit.
ECM	Energy Conservation Measure	Specific method to achieve energy reductions.
eCO2	Equivalent Carbon Dioxide	Greenhouse Gas emissions as compared to the reference unit of CO_2 (Carbon Dioxide).
EO80	Executive Order 80	"North Carolina's Commitment to Address Climate Change and Transition to a Clean Energy Economy" signed by Governor Roy Cooper in October 2018
ESCO	Energy Savings Company	An ESCO provides research, proposals, equipment, and installation for ECM's on a for-profit basis.
ESPC	Energy Savings Performance Contract	An ESPC is a partnership between a Federal agency and an ESCO. ... The ESCO guarantees that the improvements will generate energy cost savings sufficient to pay for the project over the term of the contract (source: Wikipedia).
EUI	Energy Use Intensity	EUI is a measure of energy efficiency: It is the amount of energy used per year normalized to the size of the campus, measured in BTUs per square foot at the site. This allows comparison of different sized buildings or campuses. A lower number is better.
GHUI	Greenhouse Gas Use Intensity	A measure of the greenhouse gas efficiency: GHG Emissions per year normalized to the size of the Campus. Measured in MTeCO2/sq.ft. A lower number is better.
HB1292	House Bill 1292	"An act to provide that any energy savings realized by constituent institutions of the University of North Carolina shall remain available to the institution and a portion of those energy savings shall be used for other energy conservation measures; and to expand the use of operational leases by local boards of education."
IAQ	Indoor Air Quality	"Refers to the air quality within and around buildings and structures, especially as it relates to the health and comfort of building occupants." (source: EPA.gov)
IPL	Integrated Priority List	The military term for the Appalachian State ECM list.
kBTU/sq.ft.	1,000 BTUs per square foot	The units for EUI; it is a measurement of energy efficiency for buildings. BTU is an energy measurement and it is

Term	Definition	Description
		normalized to the size of the space using the energy. See "EUI."
KPI	Key Performance Indicator	KPI's quantify a specific goal so progress towards the goal can be measured.
MTeCO$_2$	Metric Tons of eCO$_2$	Greenhouse Gas emissions as compared to the reference unit of a metric ton of CO$_2$ (Carbon Dioxide).
OOS	Office of Sustainability	Appalachian State University's Office of Sustainability.
RE	Renewable Energy	Energy coming from renewable sources such as water flow, sun, wind, etc. This definition refers to energy sources that do not produce carbon emissions, precluding the use of burning materials for energy.
SB668	Senate Bill 668	An Act to promote the conservation of energy and water use in state, university, and community college buildings," NC General Assembly, Session 2007.
SIMAP ™	Sustainability Indicator Management and Analysis Platform	Developed by the University of New Hampshire, SIMAP™ is used by Appalachian. SIMAP™ is endorsed by Second Nature and provides a simple and comprehensive online tool for measuring carbon and nitrogen footprint.
SEP	Strategic Energy Plan	The approved strategic plan providing goals and measurements as well as a tactical plan on how to achieve said targets.
USI	Utility Savings Initiative	System to measure and track energy reductions per SB668
WCM	Water Conservation Measure	Specific method to achieve water reductions.
WUI	Water Use Intensity	A measure of water efficiency: Amount of water used per year normalized to the size of the campus. Measured in gallons per square foot. A lower number is better.
ZEV	Zero Emissions Vehicle	A term defining a vehicle that does not produce GHG directly. Includes fully electric vehicles that are charged via utility grid electricity.
ZN-T	Zone Temperature	The measured temperature measured by the thermostat inside a space (zone).

2019-2020 Strategic Energy and Water Management Plan

MANDATE

We recognize that energy and water consumption management benefits Appalachian State University and its sustainability goals. Energy and water management is a responsibility of the students, faculty, and staff, and administration at each facility, guided and supported by the Physical Plant and the NC Utility Savings Initiative (USI) Liaison.

Appalachian State University will implement this Strategic Energy and Water Plan. The attached plan outlines the actions required to reduce energy and water consumption to meet the University's Goals as outlined in the "2025 Master Plan" and to be in tune with our overall goals, we must refer to our commitments outlined in "The UNC Policy Manual," the "Second Nature Climate Leadership Statement," and "Towards Climate Neutrality," while also considering the goals in the Governor's 2018 "Executive Order 80." Three of these five documents require climate neutrality by 2050.

The Chancellor is responsible for the success of the program at Appalachian State University.

The Physical Plant Energy Analyst will review energy results monthly and share any problem or success indicators with the Physical Plant Director or his Designate for action as needed. These reports and graphs are available and posted internally. The Department Heads will review progress and results quarterly and will support staff attendance at training in energy and water management at least yearly.

Strategic Energy Management Plan Mandate Goals and Measures

For 2019-2020, reduce energy and water use along with eCO_2 (equivalent CO_2) emissions from the previous year as follows:

1. *GHG (Green House Gas Emissions)*
   - Reduce facility GHG by 11.5% (from 42,036 to 37,185 $MTeCO_2$)
   - Maintain and improve fleet and vehicle GHG reductions (now 13% better than target)
2. *EUI and WUI (Energy Usage Intensity and Water Usage Intensity)*
   - Decrease the EUI by 19.9% to 78.3 kBTU/sq.ft. (go from 494 to 424 Billion BTUs)
   - Reduce the WUI by 2.5% to 16.7gal/sq.ft. (keep below 94 million gallons)
3. *Energy and Water Expense*
   - Reduce energy and water costs by at least 2.5%

I have read and support this Strategic Energy Plan for my Organization:

Gary Carter Date
Physical Plant Director

Nick Katers Date
Associate Vice Chancellor of Facilities Management

Paul Forte Date
Business Affairs Vice Chancellor

Sheri N. Everts Date
Chancellor