Clark University Greenhouse Gas Emissions Update: 2016

Clark University's total greenhouse gas emissions in 2016 were 13,368 metric tons of carbon dioxide equivalents, a small increase from 2015 which was in turn an increase over 2014. Two years is insufficient to label as a trend, however since 2009 our emissions have previously been steadily decreasing.

Background

In June 2007 President Bassett signed the American College and University Presidents Climate Commitment (ACUPCC), making Clark University a charter signatory to an exciting initiative aimed at mobilizing the resources of colleges and universities in efforts to reduce greenhouse gas emissions. The core goal of the commitment is to achieve climate neutrality with net zero greenhouse gas emissions, also known as carbon neutrality. The Clark University Environmental Sustainability Task Force (CUES) accepted the task of developing a Climate Action Plan with mitigation strategies to lead the University toward its goal of climate neutrality. In December of 2009 Clark University released the Climate Action Plan (CAP), detailing strategies for the University to reduce its greenhouse gas emissions. The plan sets two goals: an interim goal of reducing emissions to 20 percent below 2005 baseline levels by 2015 (to 16,357.4 $MTCO_2e$), and the ultimate goal of carbon neutrality by the year 2030. The CUES Task Force retained responsibility for recording and reporting on Clark's emissions. In 2014 the CUES Task Force commissioned an update to assess viability of CAP strategies (i.e. changes in technology or University environment), and to recommend additional strategies with incremental goals; the update was not adopted and the CAP remains as published. The Task Force has not convened since 2014 pending the appointment of a Chair and Task Force members by President David Angel.

The CAP interim goal set for 2015, 16,357.4 $MTCO_2e$, was achieved in 2010, one year after the CAP was released. It has not been exceeded since. Achieving the significantly more ambitious goal of carbon neutrality by 2030 requires willingness on the part of all members of the Clark University community to recognize and invest in mitigation action as an institutional and personal priority, and to make the trade-offs required.

Methodology

In order to effectively manage carbon footprint and emission reduction strategies, data for a Greenhouse Gas (GHG) Emissions Inventory has been collected annually since 2008. (GHG inventories from prior years use actual and estimated data). Data is gathered from a range of campus entities and we utilize the Campus Carbon Calculator (CCC) created by Clean Air-Cool Planet (CA-CP) to calculate our emissions inventory. Once a leading non-profit organization and a standard in the field, CA-CP closed its doors in late 2013. All support operations for the Campus Carbon Calculator have been transferred to the University of New Hampshire Institute for Sustainability as of 2014. The ACUPCC was also replaced in 2014; Second Nature is the non-profit organization that currently monitors greenhouse gas reporting and manages the interests of the former ACUPCC.

In the Inventory, inputs are recorded for Scope 1 sources (on-site combustion, such as boilers and vehicle use); Scope 2 sources (off-site combustion, such as purchased electricity) and certain Scope 3 sources (other combustion such as commuting) according to ACUPCC guidelines. The six greenhouse gases inventoried are those included in the Kyoto Protocol: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydro fluorocarbons (HFCs), perfluorocarbons (PFC), and sulfur hexafluoride (SF_6). Of these six, CO_2 (produced during the combustion of all fossil fuels) and to a much lesser degree HFCs (gases that are used in refrigerants and air conditioners) have been shown to be the primary gases emitted on campus. For ease of understanding and comparison, all gases are converted to a common measure:

carbon dioxide equivalents, CO_2e. The CCC uses updated emissions factors to determine the amount of metric tons of carbon dioxide equivalent ($MTCO_2e$) added to the atmosphere by campus operations across all inventoried inputs. The results of past inventories have been reported to ACUPCC and shared with University administration via the annual Climate Action Plan (CAP) Update. The annual CAP Updates are also available at Sustainable Clark (www.clarku.edu/sustainability).

Revisions and Updates to the CCC; Impact on Data

Due to the evolving nature of greenhouse gas emission factor science, Clark University consistently utilizes the most current version of the CCC for charts and data analysis in the annual CAP Update. Therefore, previous Updates *may* show annual or category data points that differ from the current Update; included charts will reflect this. Clark's interim goal was based on 2005 emissions and the standards at the time, as were the benchmarks and mitigation strategies in the CAP; our interim goal therefore remains unchanged at 16,357.4 $MTCO_2e$.

The 2016 greenhouse gas emissions inventory uses version 9.0 of the Campus Carbon Calculator (CCC), in which emissions factors have been updated to reflect the most recent available data from EPA, E-GRID, DOE, IPCC and other public data sources. Many standards are retroactive and almost all of Clark's past data stored in the CCC from 2005-2016 is affected by various updates. Even small changes in the factors will add up over time and retroactively. For example, updates in CCC version 7.0 (2013) impacted Clark's recorded data retroactively to 2009. CCC version 6.85 (2012) included over 40 substantial updates. CCC version 6.7 (2011) included EPA revisions for certain emissions- producing activities which impacted CO_2 equivalency calculations retroactive to 2007. For full list of CCC updates as well as more information on the CCC: http://sustainableunh.unh.edu/calculator.

Benchmarking

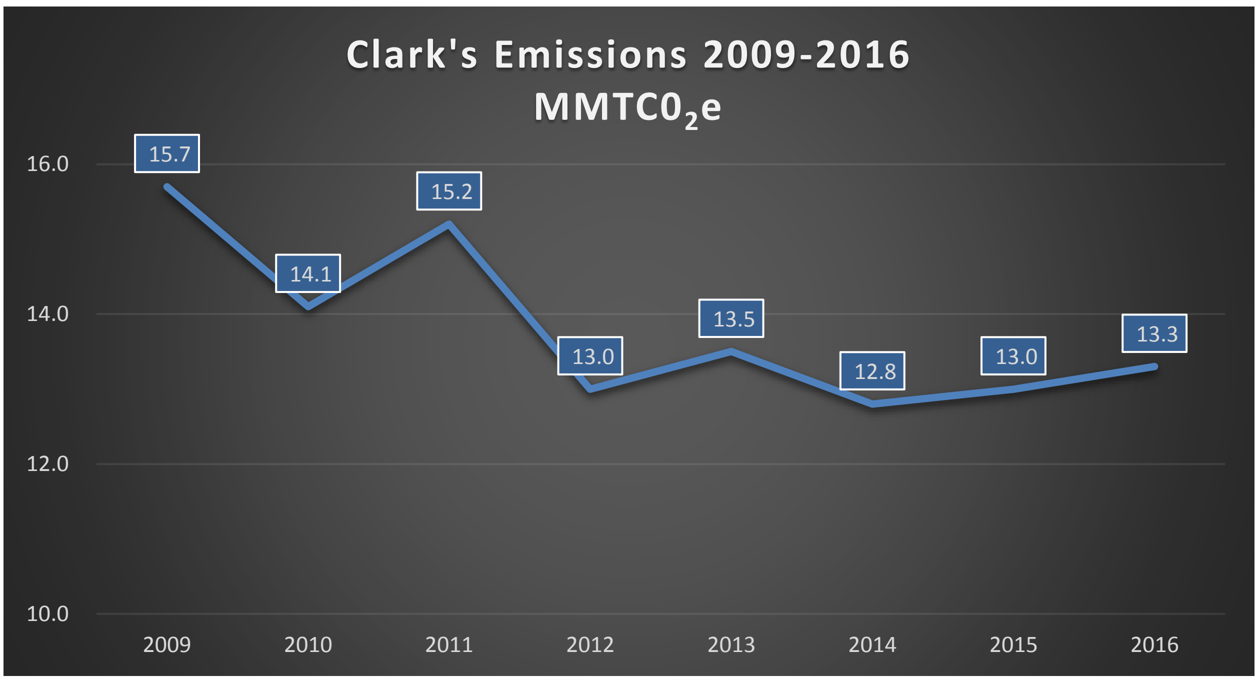
It should be noted in all data comparisons that 2014 is considered a 'benchmark-normal' year. Weather patterns were typical and therefore the amount of heating and cooling produced on campus (Scope 1) can be termed 'average'. 2014 is also a 'benchmark-normal' year in regards to campus operations; the co-generation engine operated throughout the year with normal inputs and there were no major renovation projects (Scope 2). As unforeseen or scheduled operational events occur to influence production capacity and as other factors (including changes in technology, population or footprint) influence Clark's demand for energy it is important to recognize that improving Clark's core energy efficiency and energy consumption practices will be measured against 2014 as a benchmark of 'normal' per capita and per square foot energy usage.

2016 Emissions Data: Overview

Total GHG emissions in 2016 were 13,368.1 $MTCO_2e$. This represents an increase of 2 percent from total 2015 GHG emissions of 13,123.2 $MTCO_2e$. Net GHG emissions in 2016 after offsets were 13,357.8 $MTCO_2e$, an increase of 2 percent versus 13,112.9 $MTCO_2e$ in 2015. The CAP Update details some of the probable causes for the difference year-to-year.

If and when all else is held constant, emissions will change in proportion to personal energy use. However, year-to-year differences in weather, sourcing and other conditions beyond University control will impact on- campus generated emissions from energy production and campus fleet. External factors also beyond our control will effect emissions from purchased electricity and personal transportation. As climate instability increases it is ever more important to manage those University practices that do fall within our sphere of influence to offset what is beyond our control.

Below is a chart showing the trend over time in Clark's greenhouse gas emissions, measured in $MMTCO_2e$.



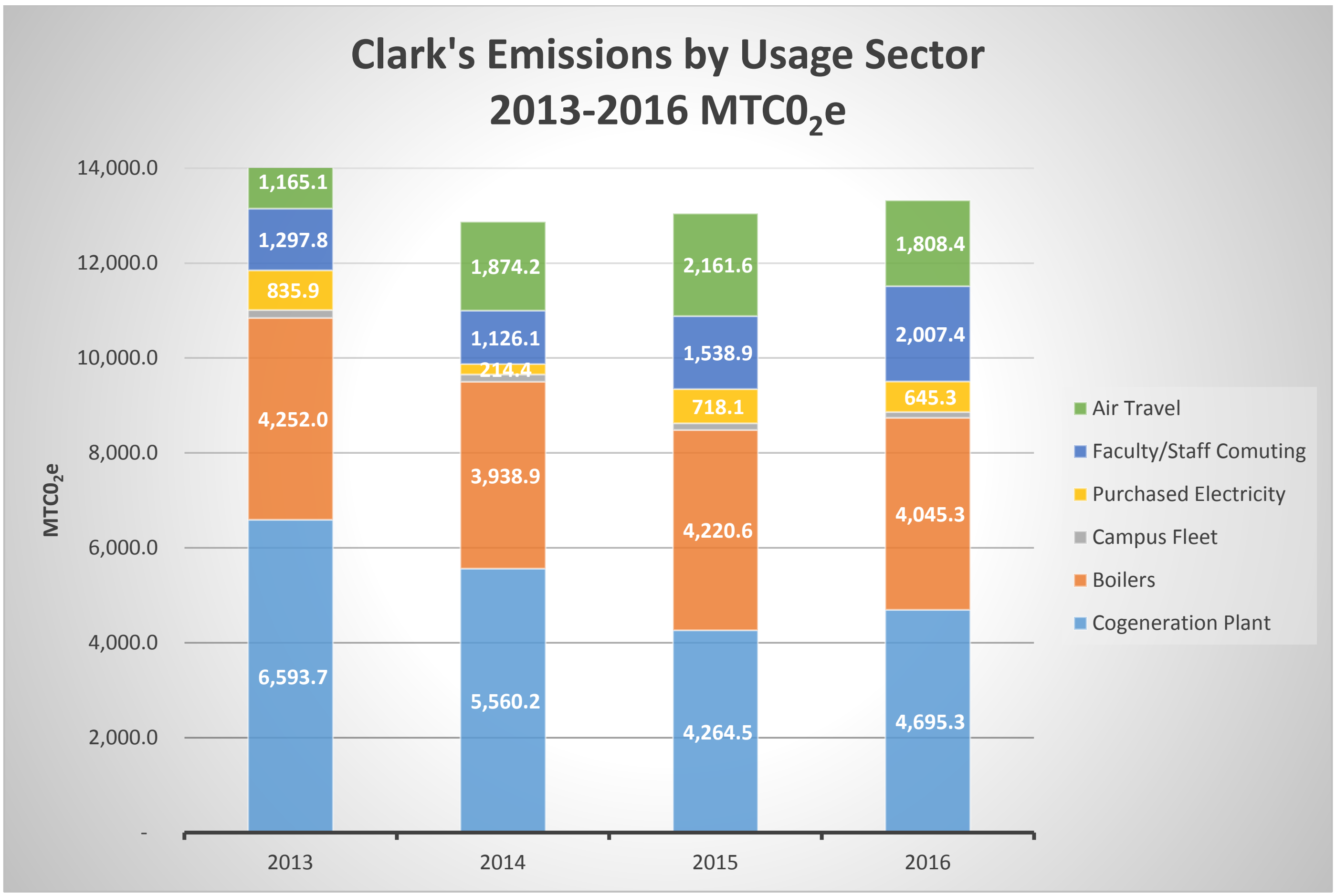
Total Greenhouse Gas Emissions in thousands of MTCO2e

Year	2009	2010	2011	2012	2013	2014	2015	2016
	15.7	14.1	15.2	13.0	13.5	12.8	13.0	13.3

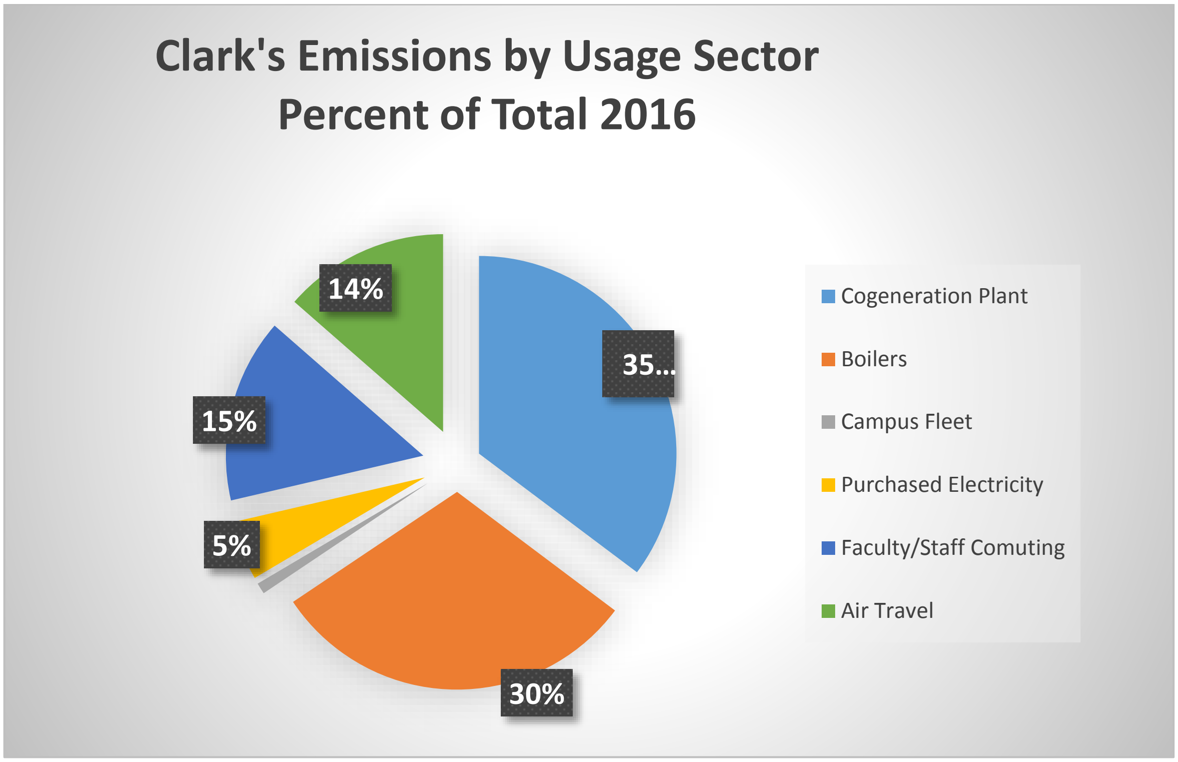
2016 Emissions: Percent by Scope & Sector

The largest source of Clark's greenhouse gas emissions is Scope 1: fuel consumed by Clark's power plant, boilers, and cogeneration engine to produce both electricity and heat. This Scope is primarily two Sectors: Cogeneration and Boilers. It comprised 65.4% of all emissions in 2016; in 2015 the same Sectors were 62.7% of all emissions. Our Scope 2 emissions derive entirely from the operations of the electric utility (National Grid) from which Clark purchases electricity for needs not served by the cogeneration plant. This Sector is termed Purchased Electricity and comprised 4.8% of all emissions in 2016 compared to 5.6% in 2015, 1.6% in 2014 and up to 30% prior to Clark's partnership with Solar Flair; more on this beneficial arrangement below. The second largest emissions source is Scope 3, also primarily two Sectors: fuel used in employee commute and University sponsored air travel. This Sector comprised 28.8% in 2016 compared to 27.3% in 2015, a slight increase. Scope 3 has continued to increase over time in the absence of institutionally managed solutions for transportation. Lesser emissions sources in Scopes 1 and 3 include refrigerants, utility-based transmission and distribution losses, waste to energy (incineration), and campus fleet; all 2% or less.

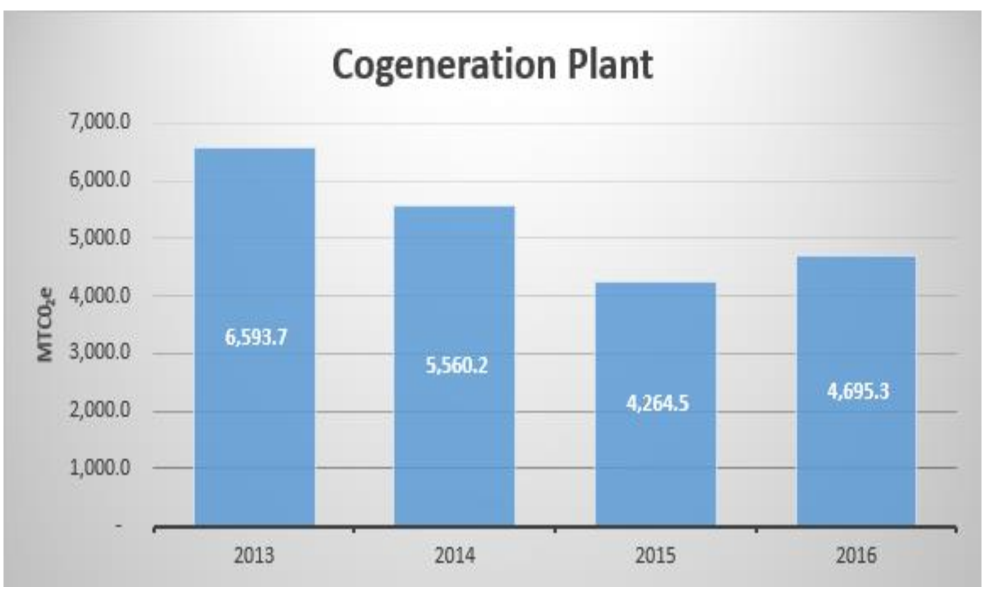
Below are charts of emissions by 2016 $MTCO_2e$ per sector and by sector percentage of total, as well as charts of individual sector emissions data from 2013-2016. It is useful to recognize overall trends within each sector, bearing in mind that the scales differ.

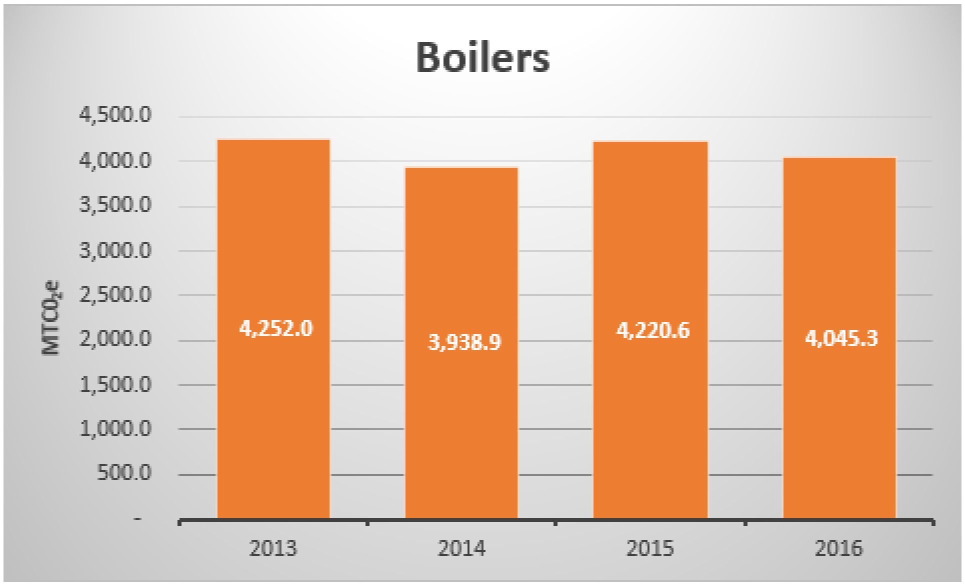


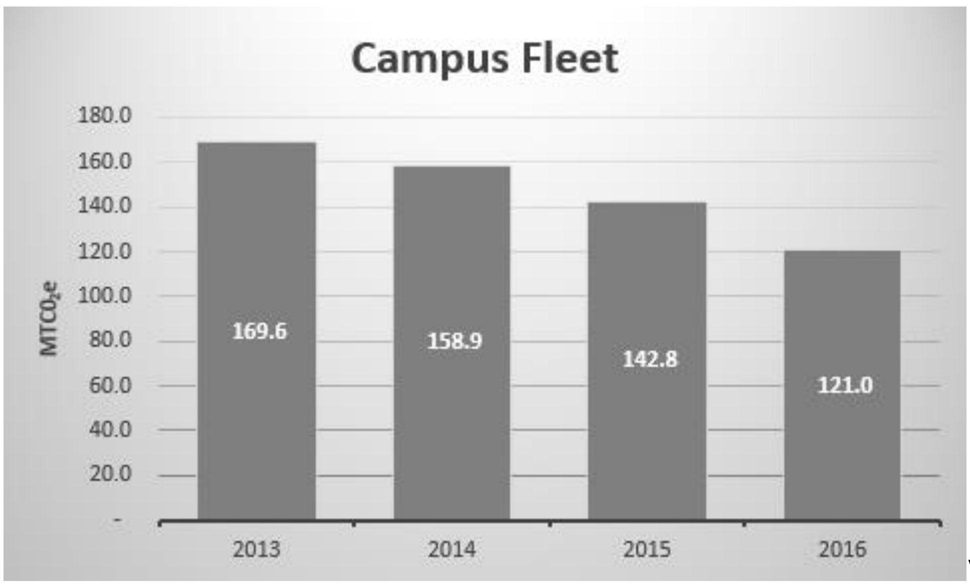
The chart below indicates percent-of-total emissions for the major contributing sectors.



The series of charts below, while at varying scales, indicate the specific volume and therefore overall trend of individual contributing sectors from 2009 – 2016. All measures are in MTCO2e; totals per year are found in the stacked bar chart above.




Boilers
4,500.0
4,000.0
3,500.0
3,000.0
2,500.0
2,000.0
1,500.0
1,000.0
500.0
-
MTCO2e
4,252.0
3,938.9
4,220.6
4,045.3
2013
2014
2015
2016


Campus Fleet
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
-
MTCO2e
169.6
158.9
142.8
121.0
2013
2014
2015
2016

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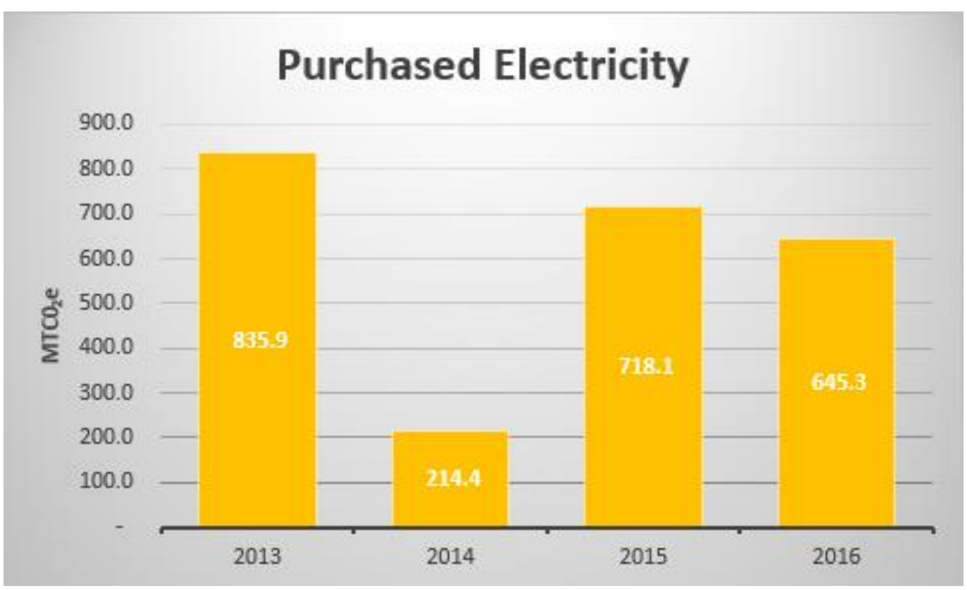
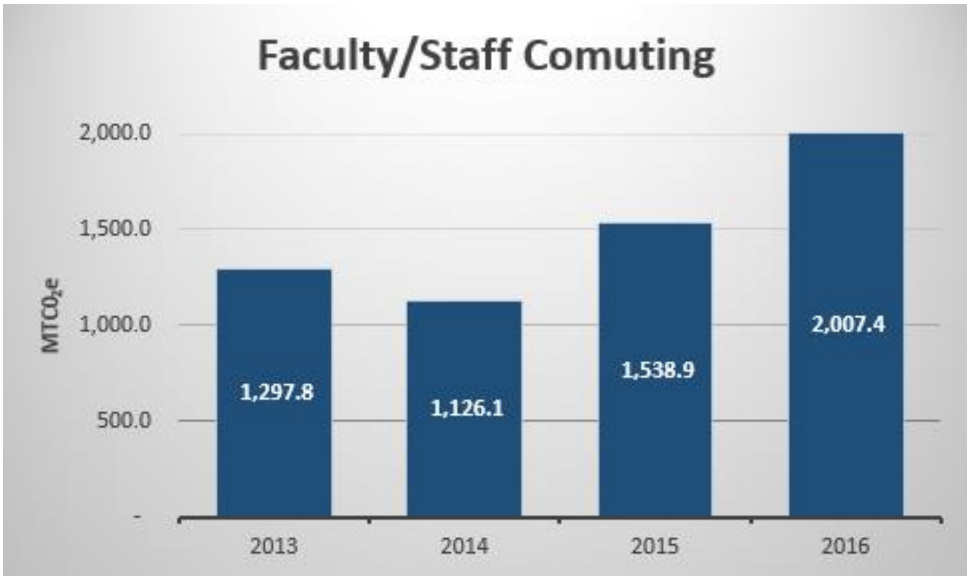

Purchased Electricity
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
-
MTCO2e
835.9
214.4
718.1
645.3
2013
2014
2015
2016



Explanations: Scope 1, On-Site Combustion from Co-Generation and Boilers

The cogeneration engine was not operating for three months in 2016 but for the balance of the year operated at peak efficiency. This is not dissimilar to 2015 when the co-gen was also out of operation for several months. However, the emissions from both co-generated electricity and co-generated steam (for heating and cooling) are larger in 2016 than 2015, attributable to increased demand and an extended heating season in the spring of 2016. Emissions derived from boiler operations are relatively stable.

Explanations: Scope 2, Purchased Electricity

While Clark's cogeneration plant provides most of the electricity for central campus, we purchase electricity for several reasons: to supply buildings that are not connected to the co-gen, to supply excess demand outside of co-gen capacity, and when the co-gen is not operational. We purchased 100% of all demanded electricity during the period that the cogeneration engine was non-operative in 2016.

Other Impacts: Scope 2

Solar Flair: 2016 marked the second full year of our partnership with Solar Flair providing Clark solar energy "credits" through what is known as an alternative PPA. In 2016, the solar production credit accounted for 48% of Clark's total purchased electricity as measured in kWh, and enabled us to decrease our reported emissions by this amount. This is nearly identical to 2015. Solar Flair's farms are operating at full build-out production capacity. Therefore, any additional decreases in Scope 2 emissions will require that Clark commit to comprehensive energy efficiency, targeted management of consumption practices, or additional renewable energy sources. (For a full explanation of Clark's arrangement with Solar Flair and National Grid, please see the CAP Update 2014).

Alumni and Student Engagement Center Solar Array: Clark's new building was opened in August 2016. The rooftop solar array can produce up to 50% of the building's electricity demand as designed. Because the building is all-electric (heating and cooling as well as lighting, equipment and appliances) and is not connected to the co-gen, electricity demand in excess of on-site solar production will be Scope 2, purchased electricity; those emissions are included in the 2016 total. ASEC is expected to receive LEED Platinum certification and includes a number of energy efficient features, some of which are engineered systems (i.e. programmed occupancy sensors) and others of which are user-dependent (i.e. manually closing shades). However, the building interior design and specifications were altered at a later date which may make it less energy-efficient overall. With less than five months operation and pending meter adjustments we will not include more detailed ASEC data (i.e. % of solar in total demand) in this Update.

Excess Production: The cogeneration engine runs consistently at optimum load and produces more electricity than campus can use during low-demand hours. This kWh excess production is returned to the electric utility grid without any offsetting credit, and Clark incurs the full burden of production-based emissions without actually using all of the electricity. The 2016 amount is approximately 6.6% of total production, or 387 $MTCO_2e$. The University is close to the end of negotiations with National Grid to establish net metering, in which Clark would receive payment for the excess electricity transferred to the grid. However, under this agreement we would still include any produced emissions in our reporting.

Explanations: Scope 3, Commute and Travel

Scope 3 increased 3% in 2016 versus 2015. Daily (vehicle) commute emissions increased while the air travel emissions decreased. Neither study abroad nor student commute is included in Clark's version of the greenhouse gas emissions inventory. To calculate emissions from daily commuting we assume a full-time employee annual mileage based on survey data rather than actual recorded mileages, and extrapolate with full-time and part-time employee data provided by the institution. As noted previously, until and unless there are University-supported solutions to the single-driver commute, such as offset incentives, carpooling and shuttle programs, or telecommuting, this emissions source will continue to increase.

To calculate air travel emissions, we use industry-accepted average cost-per-mile standards and actual University travel expenses. (Although based on assumptions, the calculation method has remained consistent year to year and therefore provides a valuable metric). Air travel produces a large amount of emissions due to the magnified effects of fuel combustion at high altitudes, so even a small change in directly-financed air travel has a significant effect on Scope 3 emissions. Institutional solutions include incentivized carbon offsets, changing behavior to travel less frequently or more efficiently, and electronic options such as video conferencing. Certainly air travel for necessary conferences, recruitment and other institutional functions is vital to the continued success of Clark University. As is the case with faculty and staff commute, this data will not change significantly until viable alternatives are enacted.

Energy Use on Campus

The Climate Action Plan's goals and mitigation strategies, including energy management strategies, are expressed in $MTCO_2e$. There is a direct relationship between fossil fuel combustion to support energy consumption and $MTCO_2e$. Technology-dependent strategies that reduce energy consumption (for example lighting efficiency, mechanical system upgrades) will reduce $MTCO_2e$ although they may be offset by other non-technological increases such as a larger population or physical space footprint. For example, by 2013 Clark had completed a program of large-scale technology-based energy and lighting improvements, and although we can track building-specific energy usage data it is challenging to isolate a specific technology impact due to other input variables. Non-technological mitigation strategies (for example personal energy conservation practices, maximizing use of space) are harder to quantify than technology strategies but in the long run equally significant in managing Clark's energy consumption patterns as they will have a long term and aggregate effect. At this time there are no plans for additional comprehensive improvements in energy systems or efficiency, although incremental projects are on-going. We measure electrical energy and thermal (heating) energy.

Electricity

Actual total campus electrical load (Scope 1 electricity produced in the co-gen plus Scope 2 purchased electricity) of 12,638,642 kWh presented a 2.6% increase compared to 2015, which was a 7.8% increase over 2014. The electrical load in 2016, less the solar credits, equates to 2,980 $MTCO_2e$. The campus load has increased steadily since 2012, due to a variety of factors including increased population, additional personal and academic electronic use, and hotter summers requiring more air conditioning.

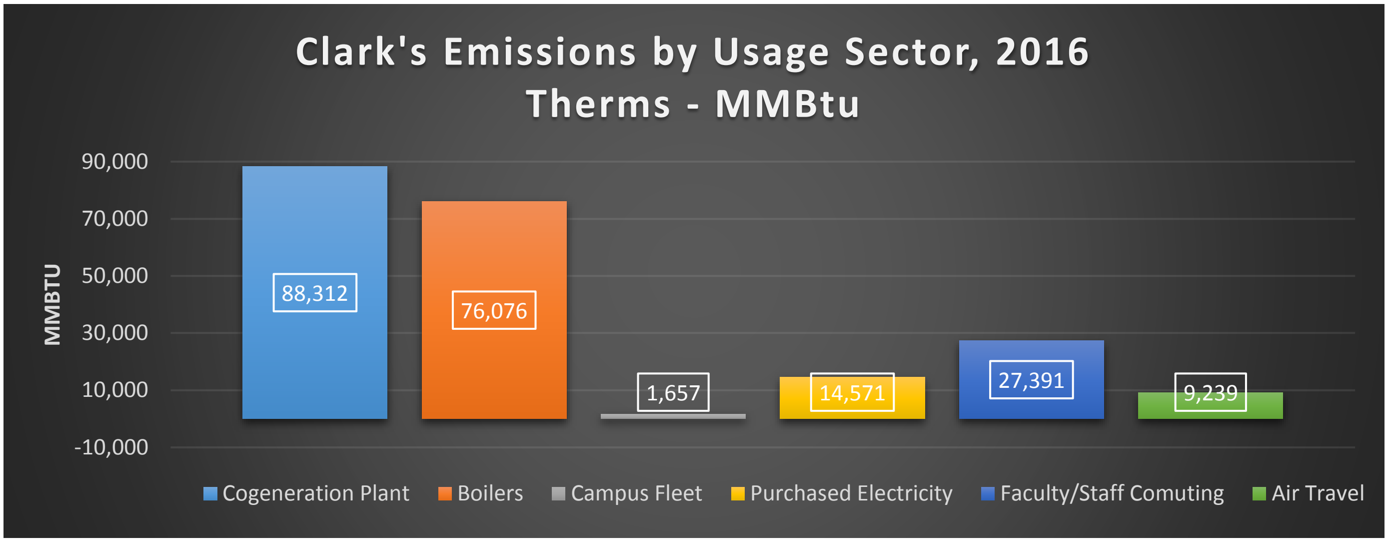
Heat

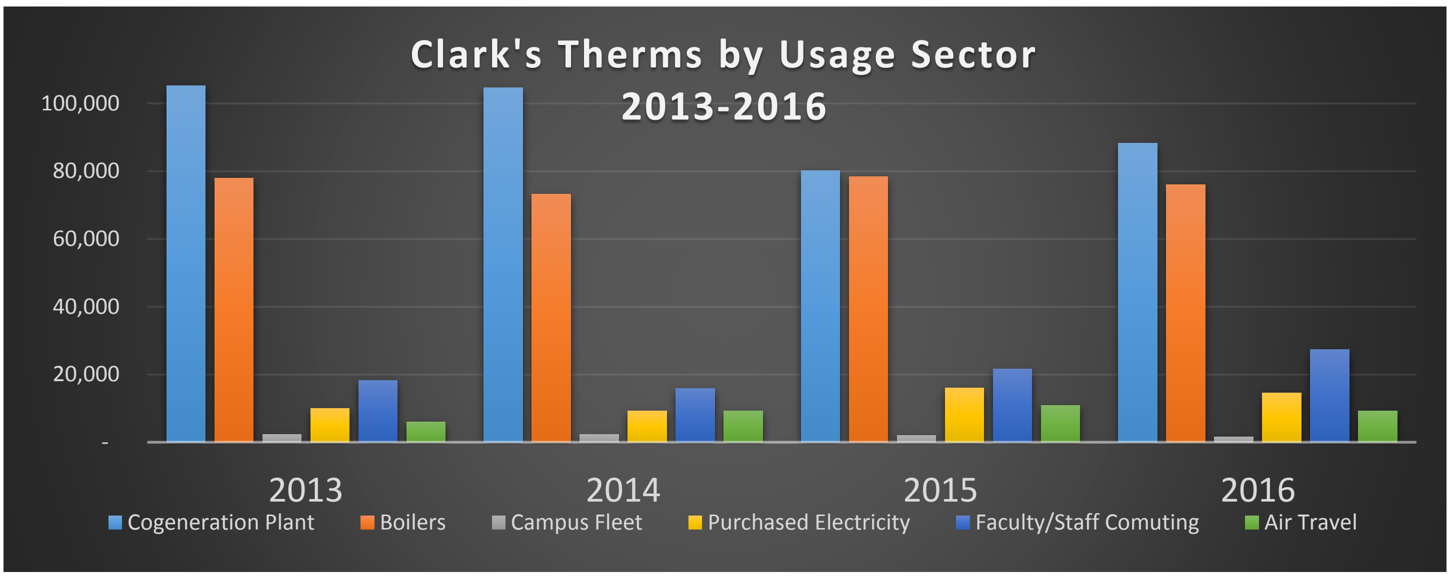
Clark's 2016 thermal energy use for heating was similar to 2015, at 6,406 $MTCO_2e$. This measure has remained relatively constant since 2012; until and unless there is University support for lower ambient temperatures and reduced set points or an investment in our control technology, it is likely to vary along with seasonal temperature variations, University space use and closure practices, and population.

Therms

As there is a direct relationship between energy consumption and $MTCO_2e$ created, it is helpful to examine the energy-related greenhouse gas inventory data in terms of a standard unit of energy measurement: therms. This is expressed in million British thermal units, or MMBtu's, and is in common use when evaluating energy output or overall usage regardless of source. Scopes 1, 2 and 3 can all be expressed in therms to indicate energy across sectors. An energy consumption profile differs from an emissions profile; it evens out the impact of different Kyoto Protocol gasses to a common measure. The calculations are based on EPA standards in use and derived from the CCC.

In the charts below, kWh, fossil fuel in gallons and natural gas are expressed in MMBtu's to provide a comparative analysis of actual energy consumption across sectors and across time.





MMBtu	**2013**	**2014**	**2015**	**2016**
Cogeneration Plant	105,211	104,581	80,209	88,312
Boilers	77,951	73,174	78,338	76,076
Campus Fleet	2,394	2,251	2,035	1,657
Purchased Electricity	9,949	9,253	16,090	14,571
Faculty/Staff Commuting	18,258	15,849	21,672	27,391
Air Travel	5,952	9,272	10,830	9,239

Conclusion

Greenhouse gas emissions for 2016 are similar to the previous year, with a 2% increase that cannot be directly attributed to a particular causal factor. 2015 was a landmark year in our Climate Action Plan, the year of our interim goal to reduce emissions 20% below baseline. This interim goal was actually achieved in 2010 and has not been exceeded since. The University has no other interim goals between now and our commitment to net zero emissions by 2030. Where are we in relation to our next and ultimate goal?

As of 2016, Clark has reduced total emissions by 17.2% over the 2005 baseline. Much of that reduction has occurred from CAP mitigation strategies and large-scale investments implemented in 2009-2013. From 2009 until 2016, Clark has reduced total emissions 14.8% percent while our physical footprint, use of electronics, and student population has grown. To put this seemingly impressive statistic into the larger context, however, if we continue the same rate of emissions reduction and hold all else constant in a business as usual strategy, by 2030 we will have reduced emissions by 26% percent over baseline but still be less than halfway to our ACUPCC commitment and carbon neutrality goal.

There is much uncertainty in looking 16 years ahead. Taking advantage of future developments in technology may provide exponential reductions. Our long-established practice of efficiency upgrades and retrofits as appropriate and affordable will continue to have incremental impact. A number of strategic initiatives explored in the CAP and in other avenues but not yet enacted may prove significant if implemented, while voluntary behavior change can aggregate and show results over time. Perhaps re-visiting the CAP with updated mitigation strategies will be successful. The purchase of carbon offsets is a last resort, but unless we aggressively move to enact all of the above and go beyond our to-date annual rate of emissions reductions, Clark will be forced to enter the carbon offset market to meet its 2030 Climate Action goal.

Scope 3 has emerged as the true and as yet unaddressed challenge. Scope 1 or 2 can be directly impacted by investments in operations-based technology and efficiency solutions. Scope 3 on the other hand requires soft-resource investment in policy and institutional support for broad behavioral change. For example, University commitment to well-monitored programs and institutional incentives for alternatives such as telecommuting, shuttle service, supported car and van pools, managed parking, or personal carbon offsets combined with a mandate toward whole-campus engagement could reduce Scope 3 emissions. Clark is not alone in struggling with Scope 3 realities.

Although we have reached and to date retained our interim goal, it is clear that business as usual for the next 14 years will not achieve the goal of the Climate Action Plan without relying on the carbon offset market mechanism. Continued expansion of the University combined with continuing unstable weather patterns make achieving our 2030 goal of carbon neutrality extremely challenging without addressing significant behavioral, habitual and technological inputs as a community, and without investing in them financially, operationally and personally. Clark’s Climate Action Plan provides a roadmap to effectively achieve our Climate Commitment goals, however there is still much to be accomplished that will require the commitment and ingenuity of the entire Clark community if we are to meet our goals of climate neutrality - net zero emissions - by 2030. As the Clark University Environmental Task Force has noted in several reports, the low-hanging fruit has been captured via CAP mitigation strategies and while operations-based investments in technology will continue, to truly impact our emissions a whole-campus approach that includes every employee with high levels of administrative support and direction to ask for significant behavior change, as well as changing long-held habitual and institutionally-condoned practices, will be necessary before 2030.