

## **Clark University Greenhouse Gas Emissions Update: 2017**

Clark University's gross total greenhouse gas emissions in 2017 were 13,599.5 metric tons of carbon dioxide equivalents, representing a small increase from 2016 which was in turn an increase over 2015: three consecutive years of increasing emissions. Our net greenhouse gas emissions after offsets were 13,589.2.

### **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% below 2005 baseline levels by 2015 (to 16,357.4 MTCO<sub>2e</sub>), 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<sub>2e</sub>, 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: Calculator**

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 for prior years use largely estimated data). Data is gathered from a range of campus entities, and their cooperation is essential to accurate and complete calculations.

From 2009 until 2016 we utilized the Campus Carbon Calculator (CCC), created by leading non-profit Clean Air-Cool Planet (CA-CP) and recommended by the ACUPCC, to calculate our emissions inventory. After CA-CP closed its doors all support operations for the Campus Carbon Calculator were transferred to the University of New Hampshire Sustainability Institute in 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. This year, 2017, UNH discontinued support for and updating of the CCC. Colleges and universities were presented with three options to continue reporting and tracking greenhouse gas emissions: create an internal mechanism, continue to use the CCC without updates or support, or purchase a new on-line calculator from UNH's Institute for Sustainability, [SIMAP](#). Clark opted for a one-year trial of SIMAP. Many of the data fields are identical to the CCC, however some are removed and others have been combined. The results and reports from SIMAP are similarly truncated. The core data calculations and measures of greenhouse gas emissions gases are however identical and there is confidence from Second Nature that SIMAP is a valid replacement for the CCC.

## Methodology: Inventory Inputs

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). The six greenhouse gases inventoried are those included in the Kyoto Protocol: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), hydro fluorocarbons (HFCs), perfluorocarbons (PFC), and sulfur hexafluoride (SF<sub>6</sub>). Of these six, CO<sub>2</sub> (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<sub>2</sub>e. The results of past inventories in CO<sub>2</sub>e and Kyoto Protocol gasses have been reported to ACUPCC/Second Nature and shared with University administration via the annual Climate Action Plan (CAP) Update. The annual CAP Updates are also available at [Sustainable Clark](http://www.clarku.edu/sustainability) (www.clarku.edu/sustainability).

## Updated Equivalencies; Impact on Data

Due to the evolving nature of greenhouse gas emission factor science, third-party calculators such as the CCC and SIMAP update emissions factors annually with information from the EPA, IPCC, E-grid, DOE and other sources to determine the amount of metric tons of carbon dioxide equivalent (MTCO<sub>2</sub>e) added to the atmosphere by campus operations across all inventoried inputs. Clark University has consistently utilized the most current version of third party calculators (CCC or SIMAP) for charts and data analysis in the annual CAP Update. 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. Therefore, previous Updates from 2009 – 2016 *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<sub>2</sub>e.

## Benchmarking

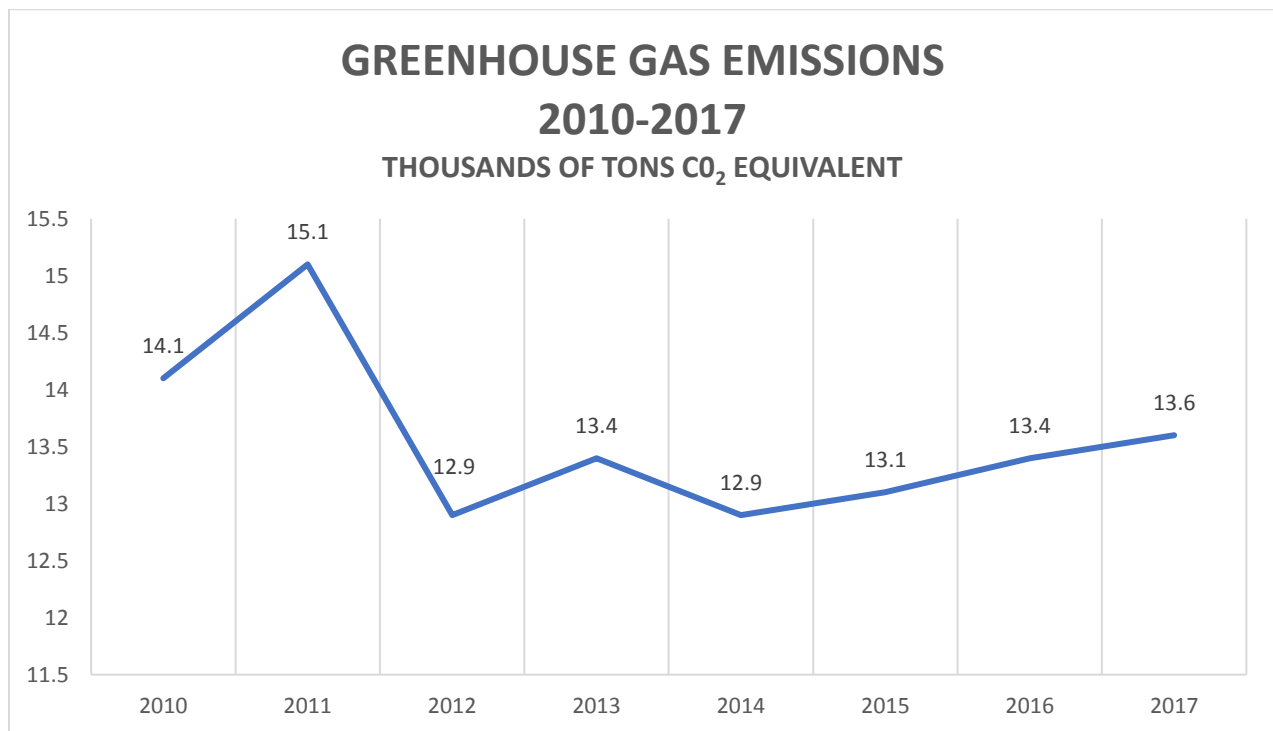
It should be noted in all data comparisons that 2014 is considered a 'benchmark-normal' year. Weather patterns were typical and therefore the amount of heating and cooling produced on campus (Scope 1) can be termed 'average'. 2014 is also a 'benchmark-normal' year in regards to campus operations; the 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.

## 2017 Emissions Data: Overview

Total GHG emissions in 2017 were 13,599.5 MTCO<sub>2</sub>e. This represents an increase of 1.73% from total 2016 GHG emissions of 13,368.1 MTCO<sub>2</sub>e. Net GHG emissions in 2017 after offsets were 13,589.2 MTCO<sub>2</sub>e, an increase of 1.73% versus 13,357.8 MTCO<sub>2</sub>e in 2016. Total and net GHG emissions in 2016 were in turn 2% larger than 2015 emissions. This report details some of the probable causes for the differences 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<sub>2</sub>e.



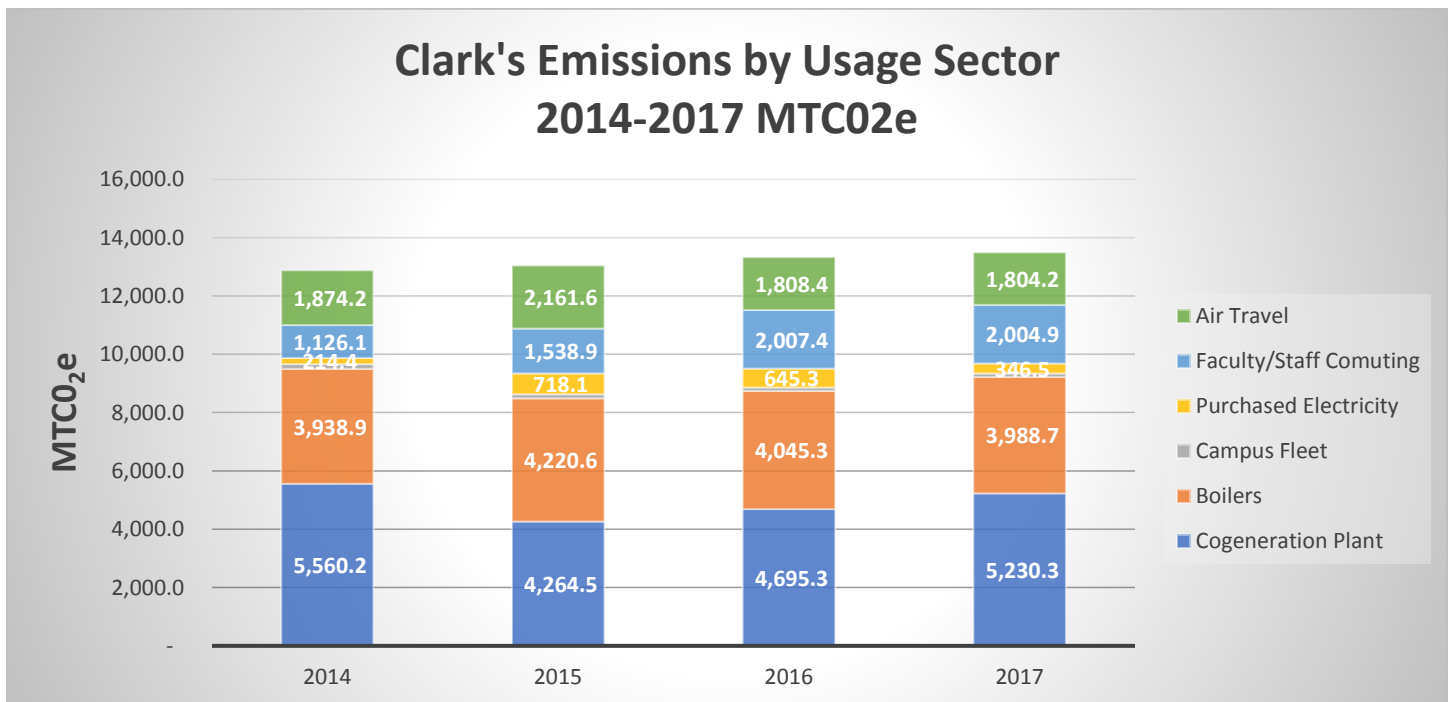
Total Greenhouse Gas Emissions in thousands of MTCO<sub>2</sub>e

Year	2010	2011	2012	2013	2014	2015	2016	2017
	14.1	15.1	12.9	13.4	12.9	13.1	13.4	13.6

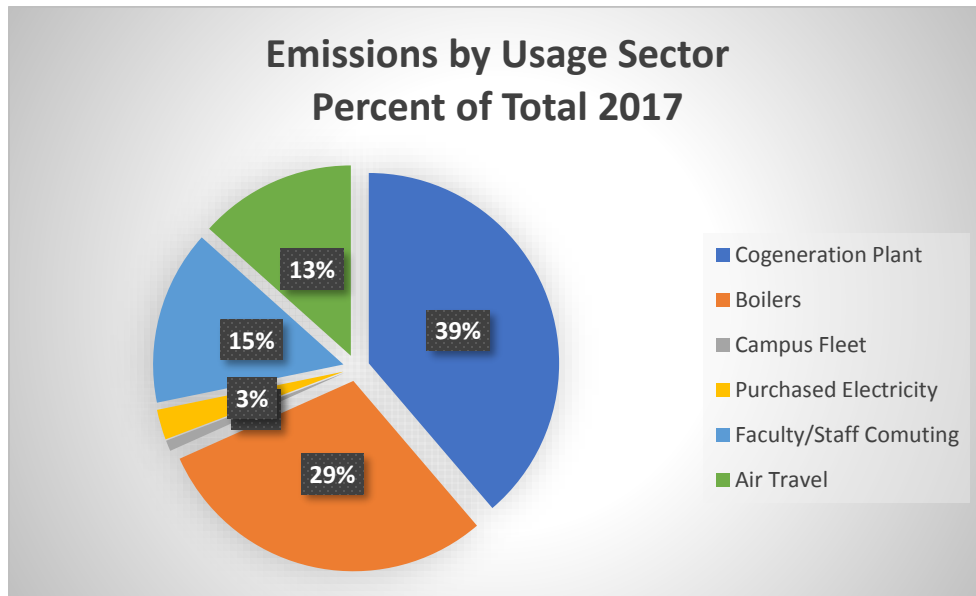
## 2016 Emissions: Percent by Scope & Sector

The largest source of Clark’s greenhouse gas emissions is Scope 1: fuel consumed by Clark’s power plant, boilers, and co-generation engine to produce both electricity and heat. This Scope is primarily two sectors: Co-generation and Boilers. It comprised 68.96% of all emissions in 2017; in 2016 the same Sectors were 65.4% 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 co-generation plant. This Sector is termed Purchased Electricity and comprised 2.5% of all emissions in 2017 compared to 4.8% in 2016, 5.6% in 2015 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 28.5% in 2017 compared to 28.8% in 2016. 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.

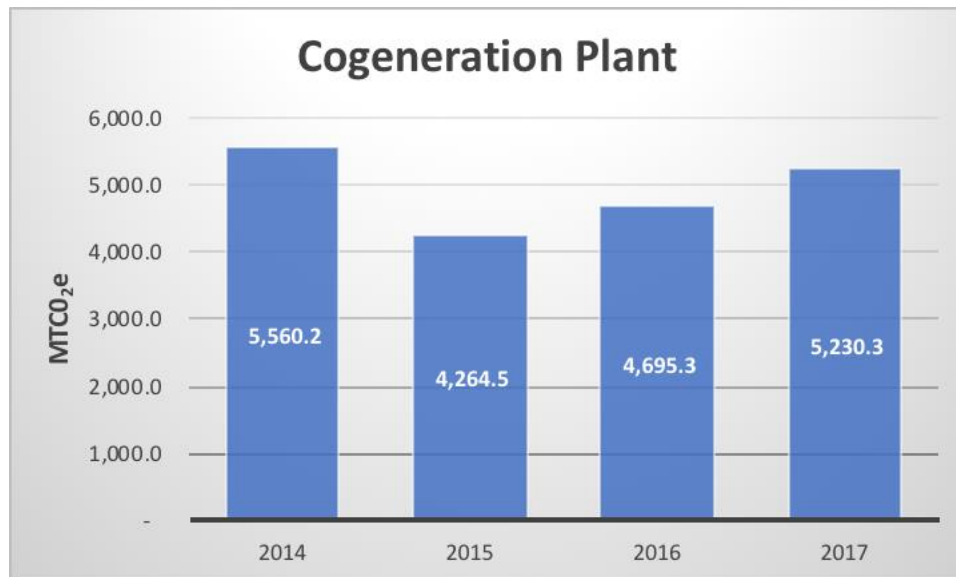
Below are charts of emissions by MTCO<sub>2e</sub> with all Sectors combined, by Sector percentage of total, and of significant individual Sectors from 2014-2017. It is useful to recognize overall trends within each Sector, bearing in mind that the scales differ (see Y axis).

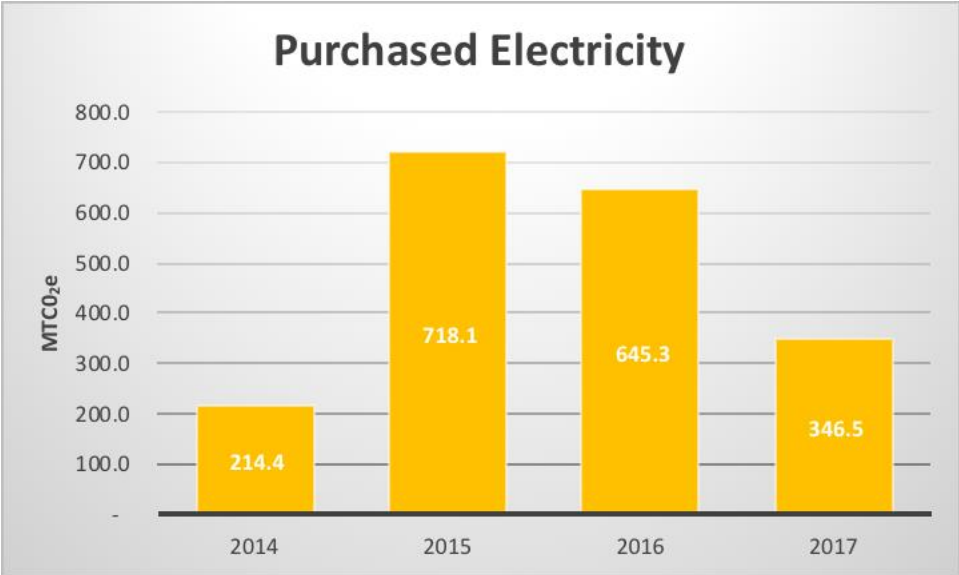
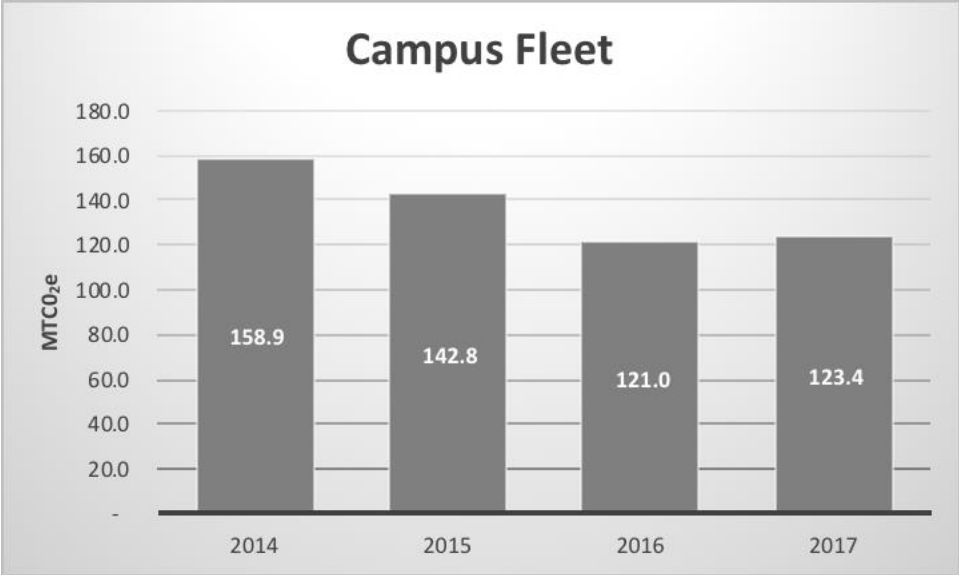
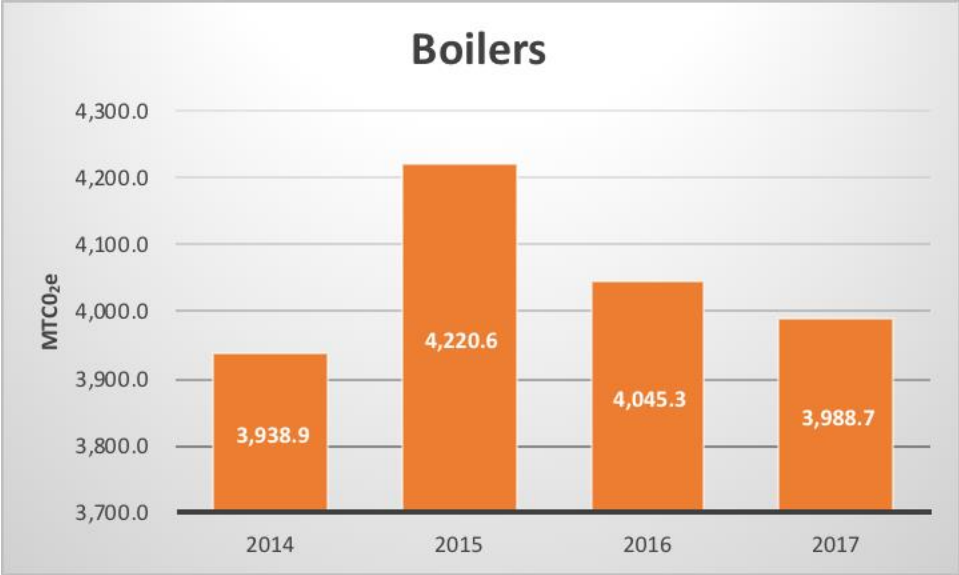


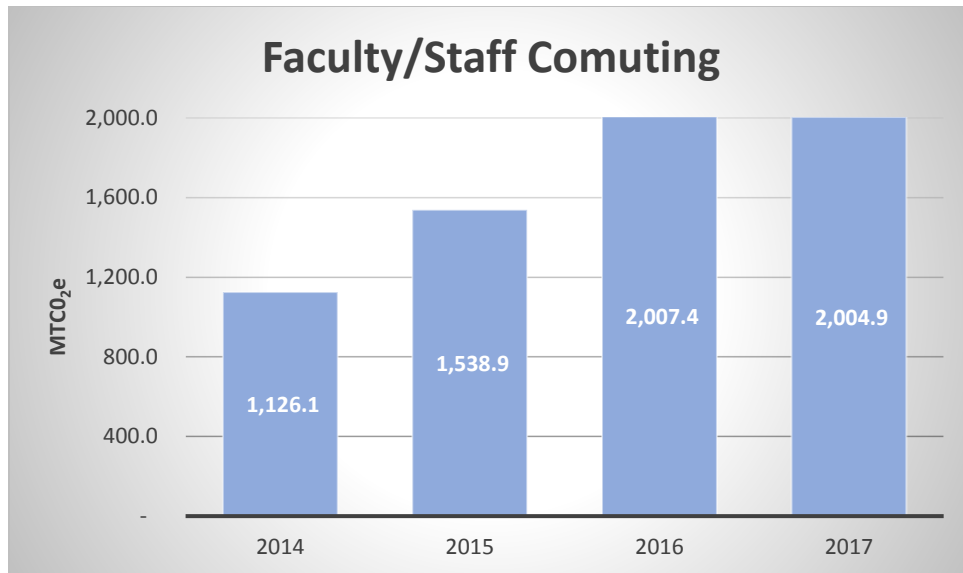
The chart below indicates percent-of-total emissions for the major contributing sectors.



The series of charts below, while at varying scales (see Y axis), indicate the specific annual volumes and therefore overall trend of individual contributing Sectors from 2014 – 2017. All measures are in MTCO<sub>2</sub>e; Scope and Sector totals by year are found in the stacked bar chart above.







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

Clark’s co-generation engine, combined with three large boilers in the power plant and multiple other boilers and generators across campus are all included in Scope 1 calculations.

- The cogeneration engine was offline for a few weeks of routine maintenance in 2017, but for the balance of the year operated at peak efficiency. This is in contrast to the last few years during which the co-gen has been out of operation for long periods (two - three months), and has a significant impact on Clark’s greenhouse gas emissions.
- The emissions from both co-generated electricity and co-generated steam (for heating and cooling) are greater in 2017 than 2016, which was in turn greater than 2015. The increase in 2017 over prior years is thus attributable to increased co-gen operating time and accompanying increase in the burning of fossil fuels to make electricity and thermal energy.

- Emissions derived from boiler operations (heating only) have remained relatively stable for the three years referenced.
- Scope 1 presents a conundrum for Clark. While emissions go up if we use the co-gen more, costs go down since we do not have to buy electricity from the utility. This trade off will become increasingly important to consider as we approach our goal of net zero emissions in 2030.

#### Explanations: Scope 2 Emissions, Purchased Electricity

While Clark's cogeneration plant provides most of the electricity for central campus, we purchase electricity from National Grid utility 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.

- Electricity purchased in 2017 to supply buildings not connected to the co-gen was 2.5% greater than the volume purchased in 2016; however with the addition of the Alumni and Student Engagement Center (ASEC) in mid-2016 our 'standard amount' of electricity purchased to serve non-connected buildings has increased by 15% overall from previous years. More detail on ASEC is below.
- The co-gen operates at maximum efficiency and capacity, but this is sometimes not enough to meet the electrical demands of all connected buildings; in 2017 the gap was 1,681 MWh or 16.4% of total connected-campus demand. In 2016, the demand gap was 26.4% of total and in 2015 it was 33% of total. This significant decrease is due to the co-gen remaining in operation through most of the year; on average and normalized the 'demand gap' is 15% of total.
- As the co-gen was on-line for most of 2017, electricity purchased to meet demand outside co-gen capacity was lower in 2017 than in previous years.

#### Scope 2 Emissions, Other Impacts

##### Solar Flair:

- 2017 marked the third full year of our partnership with Solar Flair providing Clark solar energy "credits" through what is known as an Alternative PPA. (For a full explanation of Clark's arrangement with Solar Flair and National Grid, please see the CAP Update 2014). In 2017, the solar production credit kWh equivalent accounted for 59.3% of Clark's total purchased electricity, compared to 48% in prior years. This is largely due to a considerably lower volume of kWh purchased to supply demand beyond co-gen production capacity in 2017 and to SREC's from ASEC (see below), not actually related to Solar Flair or the PPA. Clark is able to report a custom e-Grid fuel mix at this percentage of renewable energy and thereby reduce emissions that would have otherwise been derived from the standard e-Grid fuel mix. Because Solar Flair's farms are operating at full build-out production capacity, 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.

##### Shaich Family Alumni and Student Engagement Center (ASEC) Solar Array:

- Clark's new building, ASEC, opened in August 2016. ASEC is all-electric (heating and cooling as well as lighting, equipment and appliances) and is not connected to the co-gen. The rooftop solar array was designed to supply 50% of the building's electricity demand. In the twelve months of



2017, the solar array produced 180,732 kWh, or 59% of ASEC's total electricity demand. (During the summer months there was excess production, not consumed by the building; this excess was exported to the utility grid). Solar energy produced by the ASEC array directly offsets the building's electricity, so our total Scope 2 purchased electricity is reduced by the amount of kWh produced; however there is demand in excess of on-site solar production for which we purchase electricity. Emissions from net purchased electricity are included in the 2017 total.

- ASEC is certified LEED Platinum 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 post-design which may make it less energy-efficient overall.

#### Renewable Energy Certificates (SREC's):

- ASEC's solar array generates not only power for the building's needs, but also solar carve-out renewable energy certificates (SREC's) under the Massachusetts Department of Energy Resources (DOER) Green Communities program. Each certificate represents the environmental attributes of one megawatt-hour (MWh) of energy generation and is made available for sale via the New England Power Pool energy credit market. Clark has a third party vendor managing the sale of our SREC's. Due to the workings of the market and verification procedures, there is up to a six-month delay in receiving the credits for the sale of SREC's. In 2017 we claimed four fiscal quarters of applicable credits from June 2016 – June 2017 for a total of 117 MWh, equivalent to \$30,207.00.
- While our net purchase of electricity and therefore Scope 2 emissions are obviously reduced by the amount of solar energy produced and used on-site and the University receives direct financial benefit from the market activity, the creation and sale of SREC's adds to our Scope 2 emissions consistent with the EPA's Renewable Energy Certificate methodology. When an SREC is purchased on the market, it offsets emissions produced by the buyer. When an SREC is sold, however, the producer takes on those equivalent emissions through the mechanism of the SREC. We have already received the double benefit of "free" solar power and payment; we cannot "double dip" by using a sold SREC as an offset.

#### Excess Production:

- The cogeneration engine runs consistently at optimum load and produces more electricity than campus can use during low-demand hours. Until late 2017, this kWh excess production was returned to the electric utility grid without any offsetting credit, and Clark incurred the full burden of production-based emissions without actually using all of the electricity produced. The University has now been approved for net metering, in which Clark will receive payment for the excess electricity transferred to the grid. However, even under this agreement we must still include emissions from the production of unused electricity in our reporting. The 2017 amount of excess production is 720,345 kWh equivalent to 7.8% of total electricity production, or 536 MTCO<sub>2e</sub>. Viewed as a percentage of Clark's total greenhouse gas emissions, this represents 3.94% of our total MTCO<sub>2e</sub>, or six times the SREC credit from ASEC's solar array.

## Explanations: Scope 3 Emissions, Commute and Travel

Scope 3 increased 0.4% in 2017 versus 2016. Daily (vehicle) commute emissions increased while the air travel emissions decreased. 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. Neither study abroad nor student commute are included in Clark's version of the greenhouse gas emissions inventory. 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 be a barrier to overall greenhouse gas reduction when holding the commuting population (i.e. number of full time employees) constant.

To calculate air travel emissions, we use industry-accepted average cost-per-mile standards and actual University travel expenses. 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 remote conferencing. Certainly air travel for necessary conferences, recruiting 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 Consumption on Campus

The Climate Action Plan's goals and mitigation strategies, including energy management strategies, are expressed in MTCO<sub>2e</sub>. There is a direct relationship between fossil fuel combustion to support energy consumption and MTCO<sub>2e</sub>. Technology-dependent strategies that reduce energy consumption (for example lighting efficiency, mechanical system upgrades) will reduce MTCO<sub>2e</sub> 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 consumption of 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 11,729 MWh presented a 7% decrease from 2016, which was a 3% increase over 2015; 2015 was in turn a 3% decrease over 2014. There does not seem to be a discernable pattern nor a single causal explanation. Including our Alternative PPA solar credits, the total campus electrical load in 2017 equates to 3,096 MTCO<sub>2e</sub>. The campus load has remained relatively stable over time even with a variety of factors including increased population, additional personal and academic electronic use, and hotter summers requiring more air conditioning. This is a testament to our energy management and upgrades.

## Heat

Clark's 2017 thermal energy use for heating was equal to 6,498.5 MTCO<sub>2e</sub>, slightly higher than 2016 at 6,406 MTCO<sub>2e</sub>. This measure has remained relatively constant when factoring in changes in conditioned space (i.e. changes to square footage that we heat) since 2012; until and unless there is comprehensive University support for lower ambient temperatures and reduced set points and an investment in our control technology (i.e. program controlled thermostats, zone analysis and updating), it is likely to vary along with seasonal temperature variations, community demand, and University practices in areas such as space use and closure.

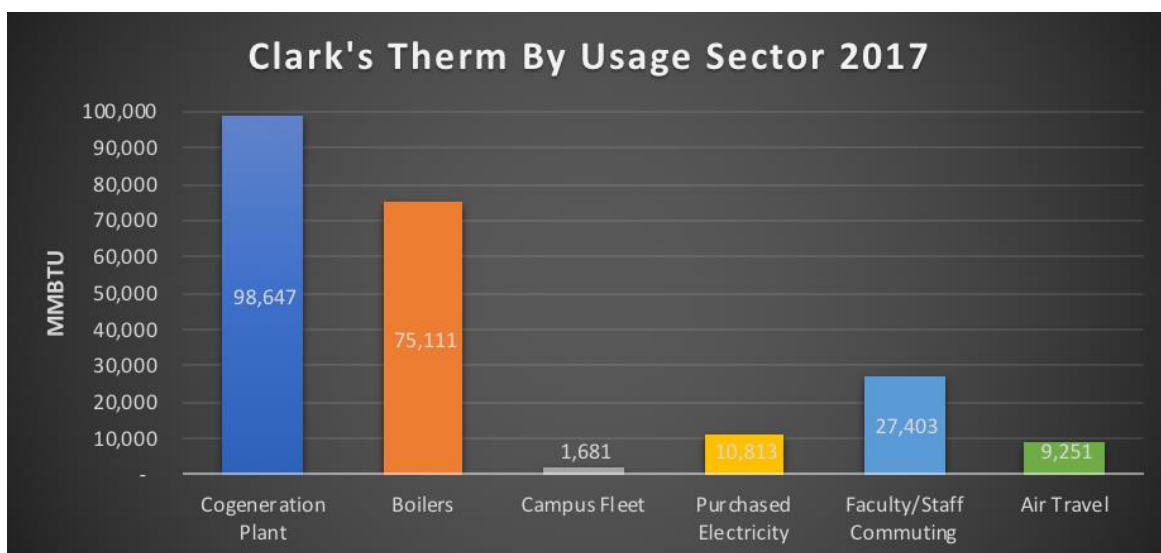
## Therms

As there is a direct relationship between energy consumption and MTCO<sub>2e</sub> 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 across industry when evaluating energy output or consumption regardless of source. Measurements from Scopes 1, 2 and 3 can all be expressed in therms to provide an alternative analysis of impact to gas emissions. An energy consumption profile differs from an emissions profile; it evens out the impact of different Kyoto Protocol gasses to a common measure. Therms are also useful to examine actual energy consumption patterns over time. The calculations are based on EPA standards in use and derived from the CCC.

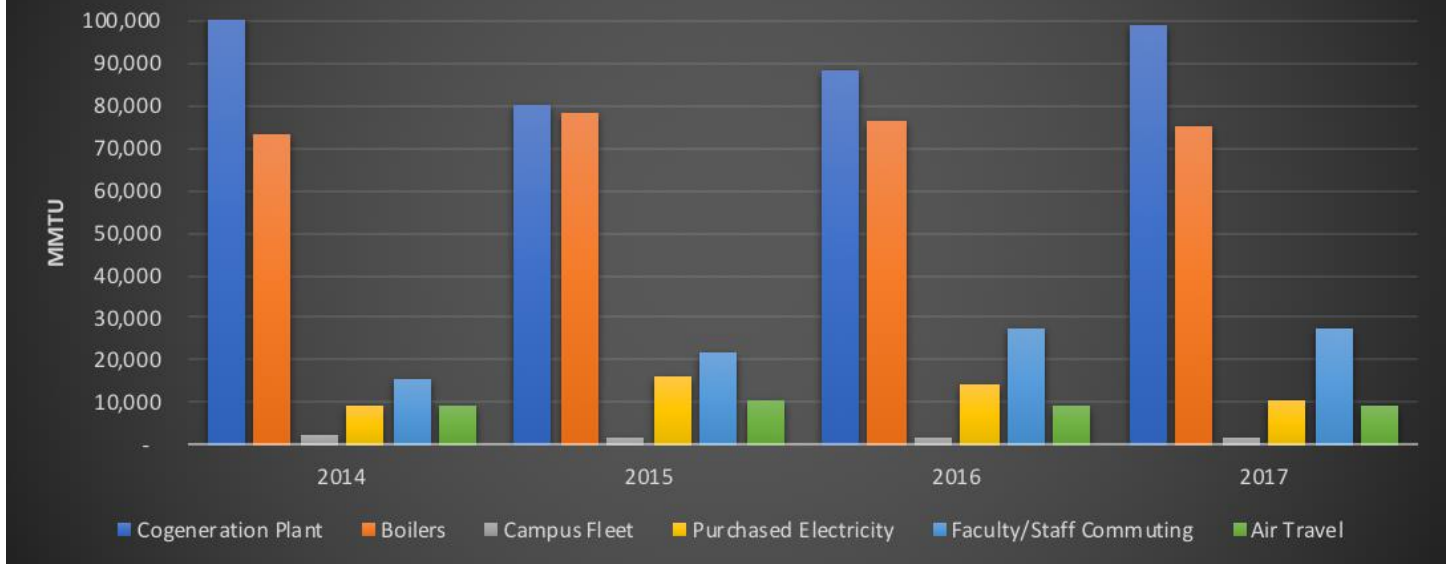
The charts below show the Sectors addressed in this report with their measures of electricity kWh, fossil fuel gallons and natural gas therms, all expressed in MMBtu's.

### Explanations: MMBtu Year over Year

The slight increase in the fossil fuel MMBtu's consumed by the co-gen is in line with the longer period in which it was in use during 2017. It should be noted that the co-gen's variable operational efficiencies factor into this calculation; 32% efficiency for electricity production and 24% efficiency for steam production mitigate this number which would have been larger at lower efficiencies. Similarly, the lower MMBtu shown for Purchased Electricity is due to the extended co gen operation and to a lesser degree to the high volume of renewable energy claimed through our arrangement with Solar Flair.



## Clark's Therms by Usage Sector 2014-2017



	2014	2015	2016	2017
<b>Cogeneration Plant</b>	104,581	80,209	88,312	98,647
<b>Boilers</b>	73,174	78,338	76,076	75,111
<b>Campus Fleet</b>	2,251	2,035	1,657	1,681
<b>Purchased Electricity</b>	9,253	16,090	14,571	10,813
<b>Faculty/Staff Commuting</b>	15,849	21,672	27,391	27,403
<b>Air Travel</b>	9,272	10,830	9,239	9,251

### Conclusion

Clark's total greenhouse gas emissions for 2017 are similar to the previous year, with a 1.73% increase that cannot be directly attributed to a single causal factor. As mentioned previously, 2017 is the third consecutive year of increased rather than decreased greenhouse gas emissions. We have exceeded our 2013 levels. This is of particular note because Clark has put considerable technological investment toward reduction since 2013: adding renewable energy via ASEC and Solar Flair; replacing an inefficient cogeneration engine and leaking distribution lines; completing energy efficiency upgrades with LED lighting, controls, motors and more; adding technology to 'smart rooms' to manage downtime energy use, and numerous other upgrades. We have also expanded our physical footprint and population. Clark has managed to maintain and even control emissions with the addition of buildings and building extensions. MTCO<sub>2e</sub> per square foot in 2017 are 0.00776; in 2013 emissions were 0.0789 per square foot. Reliable data is not available at this time to calculate the per person 'carbon footprint'.

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 2017, Clark has reduced total emissions by 16.8% over the 2005 baseline. Much of that reduction has occurred from scheduled Climate Action Plan mitigation strategies and large-scale investments implemented in 2009-2013. From 2009 (the date of adoption for our Climate Action Plan and the first year actual rather than estimated data was used) until 2017, Clark has reduced total emissions 13.3% while our physical footprint, use of electronics, and student population has grown. To put this seemingly impressive statistic into the larger context; if we continue the same rate of emissions reduction and hold all else constant in a business-as-usual (BAU) strategy, by 2030 we will have reduced emissions by 32% 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 considered a last resort within the CAP, 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 most difficult and most unaddressed challenge. Scope 1 or 2 can be and currently are 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, and there are no easy answers.

Although we have reached and have retained our interim goal, it is clear that business-as-usual for the next 13 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 due to climate change, 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.